JOURNAL

OF THE

GEOLOGICAL SOCIETY OF DUBLIN.

VOL. VIII.

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Geological Society of Dublin.

INSTITUTED, 1831.

This Society meets on the second Wednesday in each month, from November to June, both inclusive, at eight o'clock P.M., for the reading and discussion of Papers on Geological subjects. The Meetings are held in the new Museum Building, Trinity College. The valuable Museum of the Society has been incorporated with the University Museum. The Society possesses a small but useful Library, and a valuable collection of Maps and Charts for the use of its Members.

Members are admitted on being proposed by one Member, seconded by another, and approved by the Council.

The terms for Resident Members are One Pound on admission, and One Pound annually; or Ten Pounds, Life Composition.

Non-resident Members are admitted on a Composition of Five Pounds.

Undergraduates are admitted as Associate Members on paying Five Shillings, and being proposed and seconded as ordinary Members.

The question having been occasionally asked, "What was the nature and object of the Geological Society of Dublin?"—the Council of the Society have deemed it advisable to draw up and issue the following Programme:—

The Geological Society of Dublin was founded in the year 1831, under the Presidency of the Rev. Bartholomew Lloyd, then Provost of Trinity College.

Its object was declared to be the "investigation of the mineral structure of the earth, and more particularly of Ireland."

The original Members were 168 in number, including some of the most distinguished names among the scientific and learned men of the day, many of whom still remain Members of the Society.

The Society has partaken of the fluctuating fortunes of the country, but never ceased to hold its meetings, although its publications were for some years suspended. In the year 1847 it transferred its Museum to Trinity College, in return for the offer of a place of meeting within its walls, which should relieve the funds of the Society from the payment of rent. Since then it has always held its Meetings within the College, and has been continuously indebted to Dr. Lloyd for the use of a room for its Library and the Meetings of the Council.

Although thus attached to Trinity College by the tie of reciprocal benefits, it has no necessary connexion with it beyond these; but offers a free centre of union for all those persons who feel an interest in its pursuits, and an open arena for the discussion of all questions as to the structure of the earth.

The Papers published in the Journal of the Society are of very high character; and its labours have had a most important influence in bringing before the public the practical value and scientific interest of Geology.

Some persons have expressed an opinion that a private Society was no longer necessary for investigating the mineral resources of Ireland, since that investigation has been undertaken on a large scale by her Majesty's Government. There are, however, many reasons for the existence of this Society, in conjunction with the Geological Survey, and many ways in which they may mutually be-

nefit each other. There are, for instance, important branches of inquiry of a purely scientific kind, to which the officers of the Government Survey could not devote themselves, without delaying their primary duty of the publication of the sheets of the map with their illustrative sections and explanations. There may also be occasions on which the views taken by the Geological Survey may be fairly open to discussion, from which great benefit may be derived, both to the Geological Survey and to science in general.

This is especially the case in questions in which the mineral resources of the country are concerned—a subject that cannot be too frequently discussed, or too thoroughly and completely investigated.

The object of the Geological Survey being to form a Map of the whole United Kingdom, with illustrative memoirs and sections, it is obvious that, after once completing a district, it cannot return to it until the rest of the country is finished. New workings in old mines, however, and new explorations in fresh ground, may take place in areas of which the survey is published (perhaps even in consequence of that publication); and the discoveries thus made may be most fittingly brought out at the meetings of the Geological Society, and recorded in its publications. The Map of the Geological Survey, indeed, and the publications accompanying it, so far from exhausting the scientific interest, or precluding practical research, in any district, form, in fact, merely the ground-work for new discoveries in both. The work done by the Survey is of a kind which requires a long-continued and combined operation of a number of trained men, and is often of too tedious and monotonous, as well as too expensive a character, for either private individuals or Societies to undertake. They are then relieved, by its publications, from mere surveying work, and have placed in their hands a general groundwork on which to commence their own operations, in whatever line they may select for themselves.

The Geological Society of Dublin, then, has a particular office and special duties to fulfil of a very high order in the scientific world, independently of its representing to other scientific bodies throughout the world the state and condition of the science of Geology in Ireland. Its "Journal" may be looked upon as a platform from which Irish Geologists have an opportunity of addressing their

"brethren of the hammer" in other countries, and contributing, by their descriptions of their own island, facts and principles which will have their influence on the world at large. It may in this way have no mean effect on the fame and reputation of Ireland, and its estimation in the minds of scientific men, who, like the spring of a watch, are the hidden motive power of society.

The Society is now in a highly prosperous state, with no liabilities, and with money in hand. Nevertheless, its influence and its usefulness would be much increased, if the number of its members were doubled or tripled, so as to allow it to devote a larger sum to the more complete illustration of its Journal. Papers of great importance, which would have enriched its publications, have been sent to other societies, solely because they required engraved or coloured illustrations of a more costly character than the present income of the Society allowed it to give.

Measures have lately been taken to send a copy of the Journal to all the important scientific Societies in Europe, America, India, and the Colonies, and to receive their publications in exchange. From these and other sources the Society has a small but select Library of works of reference, already containing many valuable books, which are every year increasing in number. The Society is thus enabled to afford to its Members very considerable assistance in their pursuits. The Papers published in its Journal have often much interest, either of a local or general character; and many even of the driest, such as accounts of the analysis of minerals or rocks, have been found often to possess an unexpected value, and have become the germs of researches of high order and widely-spread reputation.

JOURNAL

OF THE

GEOLOGICAL SOCIETY OF DUBLIN.

WEDNESDAY EVENING, NOVEMBER 11, 1857.

E. Wright, LL. D., in the Chair.

Minutes of last Meeting read and confirmed. Donations announced, and thanks voted.

The following gentlemen were proposed and seconded, and admitted as Members:—

John Ball Greene, Esq. (Resident Life Member), 108, Lower Bagot-street: proposed by Rev. Professor Haughton; seconded by Dr. Whitty.

John Hancock Haughton, Esq., Carlow (Non-resident Life Member): proposed by Rev. Professor Haughton; seconded by Professor Downing.

William Porter, Esq., B. A., 13, Charlemont Mall: proposed by Rev. Professor Haughton; seconded by Dr. Whitty.

Alexander Carte, Esq., M. D., Director of the Museum, Royal Dublin Society: proposed by Rev. Professor Haughton; seconded by F. J. Sidney, LL. D.

The proposed changes suggested by the Council in the By-Laws were then laid before the Society, viz.:—

Section III.—Paragraphs 1 and 2 to be replaced by the following:—

"1. The sum to be paid by each Member on admission, including his first year's subscription, shall be, at his option, £2 or £5.

"2. If an admission fee of £2 be paid, the annual subscription is £1; and if an admission fee of £5 be paid, the annual subscribtion is 10*s*. In each case the subscription becomes due on the 1st of January, and shall be paid in advance."

That in paragraphs 4 and 5, the words "one calendar month" be altered into "sixty-three days."

That paragraph 6 be replaced by the following :—

"Any person who shall have become a non-resident Life Member by payment of the sum of £5, as above, shall, if he at any time reside within twenty miles of Dublin for more than sixty-three days in any one year, cease to be a Member, unless he shall either pay an additional composition of £5, or shall pay a Subscription of 10*s*. for each year in which he shall so reside for more than sixty-three days."

Dr. Griffith being absent, his Paper, of which the following is the title, was read by Professor Haughton:—

NOTES ON THE STRATIGRAPHICAL RELATIONS OF THE SEDIMENTARY ROCKS OF THE SOUTH OF IRELAND; WITH SPECIAL REFERENCE TO THE POSITION OF THE STRATA OF WHICH THE GLENGARRIFF AND DINGLE DISTRICTS ARE COMPOSED, IN COMPARISON WITH CERTAIN DOUBTFUL CLASSES OF ROCKS IN THE NORTH OF IRELAND. BY RICHARD GRIFFITH, LL. D., F. G. S. LONDON AND DUBLIN.

IN preparing the several editions of my Geological Map of Ireland, including the last, I have found great difficulty in deciding on the class of rocks to which several extensive districts, situate in different localities in the country, ought to be attached. These districts are chiefly composed of brown and reddish-brown grits and conglomerates, some of which are quartzose, and some porphyritic, and these rocks are occasionally interstratified with gray and greenish-gray chloritic grits, alternating with purplish and brownish-red shales, and in a few instances with reddish limestone and with purple slates, having a regular cleavage in the south.

The most northern district consisting of these rocks occupies an extensive area in the counties of Tyrone and Fermanagh, extending in a south-western direction from the neighbourhood of Pomeroy in the county of Tyrone, to the north-eastern boundary of Lough Erne in the county of Fermanagh, and in a northern and southern direction from the town of Omagh to the village of Ballygawley, in the county of Tyrone, comprehending an area altogether of about 300 square miles.

The second district belonging to this series of rocks is situate in the counties of Roscommon, Sligo, and Mayo, where it forms a ridge of hills known by the name of the Curlew Mountains, forming a range of about thirty-two miles in length, the character of the strata being identical with those of the district situate to the north-east of Lough Erne, already mentioned.

The third district, composed chiefly of reddish-brown grits, is situate in the county of Mayo, and extends in an eastern and western direction from Lough Conn, along the north shore of Clew Bay, nearly to Achill Island, and in a northern and southern direction from the neighbourhood of Castlebar on the south, by the Croaghmoyle Mountains, to the base of the quartzose mountain of Nephin on the north.

These three districts comprehend the localities in which this doubtful class of rocks occurs in the north and north-west of Ireland (and I may here mention another district containing them, situate to the west of Lough Mask, in the counties of Galway and Mayo, which extends to the mouth of Killary Harbour); but in the south they occupy a very extensive district, comprehending the south-western portion of the counties of Cork and Kerry, and particularly the peninsula of Dingle. This latter district has been examined within the last three years with great care by the gentlemen employed on the Geological Survey of Ireland, under the direction of my friend Mr. Jukes, and it is chiefly on the result of my own previous examination of this district, combined with the general information obtained from him, that I am induced to introduce this matter for discussion in the Geological Society, in the expectation that such discussion may eventually lead to a final decision in regard to the difficulty of the question at issue, and thereby enable me, if necessary, to correct the colouring and the lettering which indicate particular classes of rock on my Geological Map of Ireland.

At the Meeting of the British Association of this year, held in Dublin, I brought this subject, in conjunction with Mr. Jukes, before the Geological Section, and in a paper which I communicated at the Meeting of 1843, held in Cork, I entered at some length on the discussion of the class of rocks to which the reddish-brown sandstone district, situate to the north-east of Lough Erne, should belong; and I then generally described their unconformity with the red and gray sandstones which form the base of the Carboniferous series, and also their apparent conformity with the strata of the two small Silurian districts in the neighbourhood of Pomeroy and Lisbellaw. I also stated the probability of these brownish-red rocks being Silurian, from the analogy subsisting between them in the three districts I have mentioned, in two of which we find fossils of Silurian age. At the same Meeting, in a communication on the lower Carboniferous rocks, I pointed out that at Lisnarrick the Calp rests unconformably on the brownish-red conglomerates, while on the east and south the latter appeared to conform to the Silurian strata; and I observed that the red colour can no longer be considered a test of age, as it had been shown that red beds rested on undoubted Carboniferous rocks.

From the foregoing it would appear that from an early period I was inclined to connect these conformable brownish-red sandstones and conglomerates with the Silurian system, rather than to allot them a separate place; but, owing to the deficiency of our knowledge as to the real relations of the rocks termed Devonian, and the possibility, from the fact of their overlying the Silurian, that these rocks might be of that age, I was induced to place them provisionally in the Devonian system, at the same time distinguishing them from the Red Sandstones and Conglomerates, which would occupy an unconformable and superior position, by a note to that effect on my Geological Map. I may also observe,

that their unconformity with the overlying red and carboniferous beds was noticed at the same early period, though, in conformity with the established ideas which have grown with our growth, I did not make the sacrilegious attempt, either at that time or since, of uniting the brownish-red beds with the Silurian series on the one hand, or, on the other, of neglecting the distinction between the inferior conformable red strata and the undoubted Carboniferous rocks of the north of Ireland.

At the Meeting of the British Association held in Belfast, in the year 1852, I brought forward a communication relative to the Yellow Sandstone as developed on the north shore of the county of Mayo; exhibiting at the same time a complete suite of Carboniferous fossils, which had been collected from these rocks; and I remember having been much impressed by the remarks of Sir H. de la Beche and Mr. Jukes, who had visited that locality immediately prior to the Meeting. They advised me to omit from my Map a district I had marked as Old Red Sandstone, saying that by so doing I would strengthen the case of the Yellow Sandstone; as that, from their observation of that locality, it would not appear that any true Old Red Sandstone existed, and accordingly I had expunged my boundary and letter F. But as it would have become necessary to extend this generalization all over the north of Ireland, and not being in a position of doing so, owing to my inability at the time of making a personal examination, I afterwards thought it better to let it remain on the Map for the present: subsequently, however, examinations made by myself, and others connected with me, under my direction, brought to light Carboniferous plants, and even Mollusca, far below the boundary I had originally drawn, in black shales, gray sandstones, and conglomerates, so that I became convinced that there was a very slight development, if any, of the true Old Red Sandstone in the north of Ireland. I may allude to the occurrence of such plants as Sigillaria, with ferns, and *Stigmaria ficoïdes*, discovered within the boundary of these Old Red beds, as laid down on my Map, particularly at Mac Swine's Bay, situate on the north shore of the Bay of Donegal, amongst which I would call attention to the remarkable Stigmaria now in the courtyard of the Royal Dublin Society. These plants were declared to be Carboniferous by M. Adolphe Brongniart, to whom some of them were sent, and his letter on the subject may be seen in a late Number of the Journal of our Proceedings. On the north coast of Mayo, likewise, the same plants occur, mingled with Mollusca and fish remains, and are found very low down in the series, in the yellow, and even red shales at Glenbehy River, as well as in the shales and arenaceous limestones of Bunnatrahir Bay and Carrowcor. This being the case, it would appear that most, if not all, of the red beds of the north of Ireland, should be classed with the Carboniferous system, both from their conformability and their fossils; while their unconformability with the brownish-red grits and conglomerates of the three districts I have mentioned, sufficiently separates them from being confounded with these rocks. With what series these brownish-red grits

should be classed, is a question that I trust the present discussion may determine. But in the remarks that I shall have to make on the south of Ireland, I hope I shall be able to show a series of analogous lithological equivalents, which may contribute to a satisfactory settlement in regard to the system with which they ought to be classed. I shall not enter more at length, at present, into the question relative to the northern rocks, further than to remark that there exists sufficient similarity between the three districts I have mentioned, to justify a comparison. But I shall now proceed to advert to the rocks, of which the south of Ireland is composed.

It will be seen by reference to my Geological Map, that the Old Red Sandstone strata, as distinguished in that Map both by colour and the letter F, consisting of alternating beds of red and green shales, red sandstones and conglomerates, have an extensive range in the southern counties, pervading portions of Kilkenny, Waterford, Limerick, Cork, and Kerry, as well as Clare and Tipperary. Commencing in the counties of Kilkenny and Waterford, and extending more or less continuously in an east and west direction through the counties of Tipperary, Limerick, and Cork,—we find the Old Red Sandstone strata lying conformably beneath the Lower Limestone, and Yellow Sandstone of the Carboniferous system, and resting upon the upturned edges of the Silurian rocks in an unconformable position, till, reaching the Old Red strata in the county of Kerry, they are found preserving the same relative positions, passing through Slievemish and Caherconree, to the brownish-red, and greenish-gray grits, and the red, green, and purple clay slates of the Dingle district, which conform to and overlie the fossiliferous Silurian rocks of Ferriter's Cove, these being again overlaid unconformably on the western shore at Sybil Head by the beds of the Old Red series.

No difficulty hence arises in regard to the position of the Old Red series in the south of Ireland, it having been clearly ascertained to conform to the Carboniferous strata above, while resting unconformably upon the Silurian series beneath. The only question that will arise regarding it is, as to what system it will of right belong. And here I must enter upon an explanation of the principle of subdivision by which I have been hitherto influenced. Finding, in the course of my geological researches, that certain rocks below the lowest beds of the lower Carboniferous Limestone conformed to them, and contained the same fossils, I was led to add them to the Carboniferous system, the boundary at the base of the Mountain Limestone, as it had until then been termed, being found to be far too limited. These lower rocks I was ultimately led to consider as divisible into two groups, the upper of which I proposed to call Carboniferous Slate, and the lower, Yellow Sandstone. In respect to this latter and lower of the two series, it became a question as to where the line of division between them and the red beds lying conformably beneath should be drawn; and the discovery of certain plants, apparently of a Carboniferous type, and at present known as

Sphenopteris Hibernica, *Lepidodendron minutum* and *Griffithii* (the last of which was discovered by Dr. Carte in the course of the last year), led to the adoption of the lines of boundary which have been published on the last, as well as on previous editions of my Geological Map.

Subsequently, through the researches of my friends, Professors Haughton and Jukes, as well as those of myself, imperfect casts of these plants were found very far beneath the boundary which I had originally adopted, and hence the extent of the district which I had allotted to these lower Carboniferous rocks will be found much too circumscribed. The principle, however, upon which I set out, remains intact, and as often contended for, both by Professor Haughton and myself, in numerous papers, I would again say, that the base of the Carboniferous system will extend to any zone of these plants, no matter at what depth, or in connexion with what rocks soever, found. That this may have the effect of sweeping the whole of the fish beds of Scotland,* with the similar rocks of Glamorganshire in Wales, hitherto considered to be Devonian, into the Carboniferous system, I am not prepared to deny, as it is only a natural inference from the principle which I have laid down. It is true that I have preserved the established territories of the Old Red Sandstone on my Map, curtailing it only of the Plant or Yellow Sandstone beds, as I was not prepared to risk a controversy, merely upon the grounds of the well-known conformity between the two series, without a sufficiency of fossil evidence,—statements founded upon hypothesis, no matter how well grounded soever they may appear, but upon less than indisputable scientific principles, being still open to the charge of being mere speculation or guess; and especially as I found that up to the present time it has been as much as I could do to defend the innovations which I had already made, even though the Irish geologists generally, and especially Mr. Haughton and Mr. Jukes, who, I trust, will favour us with their views, have all arrived at similar conclusions.

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* *Note added in the Press.*—R.G.—These Scotch beds would appear to be rather high in the series, from the discovery of *Sphenopteris Hibernica* in them by Professor E. Forbes, with which we have Fenestella associated at the Roughty River and Tallow Bridge; and, as remarked Mr. Jukes and Mr. Salter, this plant is accompanied by undoubted Carboniferous Mollusca in the strata known as the Coomhola Grits; but I wish to guard myself strongly against the mistake of its being supposed that I intend to make dogmatic assertions relative to the lower non-fossiliferous beds of the true Old Red Sandstone. On the contrary, I agree with the opinion so frequently and so well expressed by Professor Haughton, namely, that in considerable thicknesses of doubtful strata, without the guide of fossils, it becomes comparatively a matter of indifference as to the series with which we classify them, provided that they are sufficiently distinguished for recognition by any convenient term generally agreed upon.

I find this remark to be the more necessary, as, at the last Meeting of the British Association, held in Dublin, Colonel Portlock had fallen into a mistake of this kind; and subsequently, my friend Mr. Jukes, in his "Manual of Geology," page 436, has, by a similar oversight, ascribed to me a share in opinions of which I am wholly unconscious.

No means that could have been adopted to ascertain the age of these plants have been neglected; and besides the attention paid to their examination by Professor Haughton, I have consulted M. Adolphe Brongniart, as already mentioned, whose opinion may be seen in a translation of a letter which I lately communicated at one of the Scientific Meetings of the Royal Dublin Society. I may observe, that as I was not looking for plants with a view of including the Old Red Sandstone within my line of boundary, I did not originally discover them so low down as my friend Mr. Jukes has since done; besides, that colour being the order of the day, I limited my researches mainly to the yellow beds, discontinuing my search upon reaching the underlying red beds. But I shall be ever ready to hear with pleasure of their discovery to the very bottom of these rocks, and to recognise them, with Mr. Jukes' and Mr. Haughton's concurrence, on my Geological Map, as a group of the Carboniferous system. I may here observe, that I do not wish to be understood as aiming at a subversion of the Devonian system, whether occurring in Devonshire or elsewhere, my present observations being strictly limited to the Old Red Sandstone of the south of Ireland.

The thickness of this series of strata in the south of Ireland may be estimated from a consideration of a few typical sections. Thus, at Ballyvoil Head, looking towards Dungarvan, the strata dip at a steep angle nearly vertical, towards the south-west, and we have the whole thickness exhibited from the Silurian to the Yellow Sandstone, which is about 2500 feet. Again, the Glasha River, near the boundary of the county of Waterford, affords a very characteristic section exhibiting the thickness of these rocks. The strata in this locality dip nearly due north, at an average angle of say 50°, giving a thickness of about 3200 feet. We have also, at Coolnamuck Bridge, south of the river Suir, in the same county, where the rock dips north at an angle of about 80°, a section which exhibits a thickness of gray and red Sandstone and Conglomerate with red shale of about 2500 feet. In some places the thickness may attain a maximum of about 5000 feet. But this seems excessive as an average. The thickness of the Yellow Sandstone will be about 800 feet, so that we may assume the average thickness of the two series to be about 3000 feet. In regard to this estimation of thickness, my friend Professor Jukes has kindly lent me his assistance in corroborating these statements. It will be understood that these thicknesses only apply in the case of a perfect development of this series of rocks, as in many cases they will be found to attain nothing like such an estimation.

I may now exhibit a section* which I have lately prepared with great care, the horizontal scale being 6 inches to a mile, and the vertical 880 feet to an inch, in which the whole structure of the south of Ireland may be seen. In this the granite of the Blackstairs Mountain, and the Hill of Brandon, respectively 2400 and 1600 feet above the

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* See Plate V.

level of the sea, with two outliers of the same rock (for one of which I am indebted to the observations of Mr. Jukes), will be observed to support disturbed strata of the Silurian series of the Inistioge district, through which the River Nore takes a south-east course. These beds are a portion of the great Silurian district which occupies the south-east of Ireland, and are overlaid in an unconformable position by the Red Sandstone formation, extending from the barony of Knocktopher, in the county of Kilkenny, to the city of Waterford on the south, and to Slievenaman on the west. Continuing the line of section from Knocktopher in a western direction, we find the same Red Sandstone resting in a similar position on an outlier of Silurian, also much disturbed, which constitutes the mass of the Welsh mountains; but it is to be regretted that in the line of section which I have necessarily adopted, we have mostly to run in the strike of the Silurians, thus rendering a display of their true dip and unconformity less striking than it would otherwise have been. Proceeding still to the westward beyond Slievenaman, we find the Yellow Sandstone, being a continuation of the band containing the plants, especially *Sphenopteris Hibernica* with *Anodon Jukesii*—which, extending from Jerpoint by Ballyhale and Kiltorcan, skirts the margin of nearly the whole of the Old Red Sandstone districts of the south of Ireland. We find, I say, the Yellow Sandstone conforming to the Red Sandstone beneath, and to the Lower Limestone above, which is again succeeded in a conformable position by the Upper or Splintery Limestone, and the Coal or Culm beds, which occupy the basin to the north-west of Clonmel, and proceeding still westward by the Lower Limestone, Yellow Sandstone, Old Red Sandstone, and Silurian strata of the Galty Mountains, and passing through the Old Red Sandstone, which reposes on the Silurian strata last mentioned at its western side, we again find the Yellow Sandstone, the Lower Limestone, and the Upper Limestone regularly succeeding in the neighbourhood to the south of the town of Charleville, in the county of Cork, till we reach the great culm or anthracite district of the counties of Cork, Limerick, Clare, and Kerry, known by the name of the Munster Coal District, where a succession similar to that which I have already described will be observed. These Coal strata rest conformably on the Upper Limestone at Liscarroll, in the county of Cork, which latter again appears in an insulated elevation, situate in the interior of the anthracite district at the Taur Mountain, which rises to a height of 1300 feet above the level of the sea; the general strike of these rocks being east and west, dipping north and south at an average angle of, say, 20°. The Coal strata undulate according to the numerous convolutions prevailing in that district, and as we proceed westward to the town of Castleisland, the Upper Limestone, as at Taur and Liscarroll, similarly underlying the western edge of the culm beds, is again repeated, the descending and conformable series consisting of the Lower Limestone, the Carboniferous Slate, or Lower Limestone Shale, which latter is characterized by a profusion of well-preserved and typical Lower Carboniferous fossils at Currans, and this again rests upon the Yellow Sandstone which overlies the Old Red Sandstone of the Slievemish, Caherconree, and Castlegregory

districts. And here I may observe that we arrive at the point which will be found to be the commencement of our difficulties; and I propose to limit the observations I shall have to make in the remainder of the present communication to a statement respecting the relations of the rocks of the Dingle Peninsula, and to a comparison of those rocks with the strata which comprise the district south of the town of Killorglin and Dingle Bay, extending as far south as the valley of Kenmare; and I shall conclude by an endeavour to show that an analog yexists between the brownish-red grits of the north of Ireland, to which I have already alluded, and certain strata of the southern districts to which I shall presently advert; hoping that by such a comparison I may be able to contribute towards a removal of the difficulties with which the subject is at present surrounded.

The district of the peninsula of Dingle may be said to contain three principal classes of rocks, the first of which is the undoubted Old Red Sandstone, similar to that of Waterford, Tipperary, and Kilkenny, to which I have just referred. These strata consist of alternating beds of red conglomerate, red and gray sandstones, with reddish and greenish shales, and they rest at various inclinations on the edges of vertical and much disturbed strata, the classification of which latter presents the difficulty with which we have to contend. I may mention a few localities where the clearest unconformable junctions between these two series of rocks occur. We have them clearly exhibited north of Castlemaine Harbour; also at Beenoskee, in the precipice over a lake on the east side; and at Carrignaspaniagh, which is the continuation of the Cahirconree range; and again, to the south of Brandon Bay; so that, in a section extending from thence in a south-eastern direction, we have four repetitions of unconformable junction across the peninsula. In the face of the mountain of Caherconree another remarkable unconformable junction may be observed, the underlying vertical strata presenting zig-zag flexures, probably the evidence remaining of some prior movement. I have prepared a section* at right angles to the former, running nearly north and south across the promontory, from Tralee Bay to Castlemaine Harbour, in which some of the unconformable junctions are exhibited, and they will be found to be indisputable. At Kinard, about 700 feet above the level of the sea, east of Dingle Harbour, we have an outlier of nearly horizontal beds of Old Red Sandstone resting unconformably upon vertical beds of brownish-red conglomerate, and occasionally red slate; and at Sybil Head, on the western shore of the peninsula, we meet a similar junction. Continuing across Smerwick Harbour, from Dunurlin Head to Ballydavid Head, and thence to Brandon Head, we find the same unconformities presented as at Sybil Head, as well as south of Toompaun Mountain, near Brandon Head, where at Pierasmore, two small outliers rest unconformably, and nearly horizontally, on the greenish-gray and brownish-red conglomerate and slates of Brandon Mountain.

* See Plate V.

The invariability of these junctions between the two series leaves no room for doubt as to the age and position of the uppermost of the two, which everywhere, as in the valley of Tralee, and at the southern side in the valley of Castlemaine, conforms to the overlying Carboniferous strata.

We have now arrived at the question relative to the second class of vertical and much disturbed beds of the Dingle promontory, which immediately underlie the Old Red Sandstone, there quietly reposing on them? That they are not Old Red we have seen. Then, are they Devonian or Silurian? Not the former, certainly, if we adhere to the idea at present suggested by that term, such a violent application of it requiring an entire change of signification, it having been hitherto considered to be synonymous with Old Red Sandstone. Mr. Jukes has proposed that they should be recognised as the "Glengarriff Grits," a term of which I highly approve, as indicating their complete identity with the rocks of the Glengarriff district, to which I shall presently refer.

I need not here enter into the consideration of some local difficulties connected with certain rocks with which these Glengarriff beds are associated, such as the black slates of Annascall, as I await with pleasure to hear from my friend Mr. Jukes, who has fully examined them, the opinion he has formed. I shall confine myself to explain the grounds upon which I have classed them in my Geological Map, and it will be seen by reference to that document that I have been aware from the commencement of the question that might be raised, from an anticipatory note which I have appended on the margin, in which the pith of the considerations by which I was influenced is stated.

The Glengarriff grits in the Dingle district consist of reddish-brown, and greenish indurated sandstones, alternating with red, brownish, and purple slate, and reddish-brown slaty conglomerate, and they are identical with the strata which occupy the most part of the two remarkable promontories which lie between the bays of Dingle and Bantry, and which extend in a north-east and south-west direction from the western shores of these promontories respectively, until they unite about twelve miles north-east of Kenmare, and continue inland still to the north-east, terminating at Mount Hilary and the Boghra Mountains.

In tracing the line of section from the great Silurian district of the south-east of Ireland, through the Silurian outliers of the Welsh and Galty Mountains (or, making a detour to the Silurian and Old Red Sandstone rocks of the barony of Upperthird, and the Knockmeildown Mountains, in the county of Waterford), in passing to the boundary of the Glengarriff grits of Dingle, no change of relative position will be observed in the whole line, the Silurian invariably underlying the Old Red Sandstone unconformably, in vertical and contorted strata; and, seeing that the Old Red rocks of Dingle, in continuation, for a distance of 160 miles, and identical, as I have already mentioned, with those of Kilkenny, Waterford, Cork, and Limerick, occupy a similar position in regard to the Glengarriff grits, also in contorted and vertical beds: it appeared to me at the time, that they must form a portion of the one great

range of the Silurian rocks, which extend continuously in patches from shore to shore, east and west across the island. These grits might be higher or lower in the series, a point I did not venture absolutely to determine, though I considered them to be of more recent origin than the schistose rocks which lie to the east of the country, but still a portion, one and indivisible, of a lengthened and continuous sequence. Upon further examination however, finding them to be, as I believed, conformable with the undoubted Silurian strata, which extend south-west from Smerwick Harbour to the Blasket Islands, these strata being now considered to be of Wenlock and Ludlow age, as I am informed by Mr. Jukes; and independently at another point finding them to conform to a small outlier of Silurian which occurs on the south coast of the peninsula at Coosatorig,—I felt that I had such a corroboration of the conclusion at which I had gradually been arriving, that I had no further hesitation in at once laying down the Glengarriff grits on my Map as belonging to the Silurian system, whether the same consisted of an upper or a lower series; and as the unconformity between the upper and lower Silurian (the latter of which Mr. Jukes proposes to call Cambro-Silurian), as existing elsewhere, does not appear to me to affect the question relative to the position of the Glengarriff grits, which are associated with and conform to the former,—I do not consider it necessary to advert to that discussion further than to observe, that should such unconformity be well established over wide areas, it may ultimately be necessary to introduce a new systematic term, which at present would not seem to be sufficiently warranted, at least in Ireland.

Before passing to the consideration of the Glengarriff grits of the Glengarriff district, I wish to remark, that the fact of the derivative character of these rocks, as noticed by Mr. Du Noyer, who finds them to be composed of the debris of the underlying Silurians, containing fossiliferous pebbles in some localities), is not conclusive, in my mind, of their being an independent formation, whether to be called Devonian or something systematically new,—as I think that cases of derivative rocks sometimes occur in the same continuous series, and that such cases are rather to be expected, if we suppose the existence at points not far distant, of the contemporaneous operation of agencies of denudation and deposition.

I should have mentioned that the fossiliferous Silurian strata of the Dingle district consist of alternations of brown, gray, and green beds, containing upper Silurian fossils, purple slates, reddish and yellowish shales and sandstones, with brown sandstones, and occasional brecciated conglomerates, which latter are also found associated with the upper Glengarriff group of strata, which I now propose to consider. If we suppose that we have overcome the chief, or all the difficulties, that we have had to encounter in endeavouring to interpret the geology of the Dingle district, we will find that upon entering the territories of the Glengarriff grits of the Glengarriff district, we have, as it were, accomplished nothing towards a harmonious view of the rocks composing the south-west of Ireland.

Here at the very threshold we are apparently met with an insur-

mountable difficulty, and that is, that we actually find the Glengarriff grits graduating conformably upwards, not only into the Old Red Sandstone, all the convolutions of which they follow (this latter being identical with the Old Red of Dingle, as well as with that of Waterford, Cork, and Kilkenny); but also, as a matter of course, conforming to the plant beds of the Yellow Sandstone, such as those of the Coomhola or the Roughty Rivers, as well as to the Carboniferous Slate, the Lower and Upper Limestone and the Coal. So that, south of Dingle Bay, we have the Glengarriff grits conforming to the Old Red Sandstone and the Carboniferous series; while north of the bay we have them conforming to the Silurian rocks, and at the same time underlying the Old Red Sandstone and Carboniferous strata unconformably.

The Old Red Sandstone of the promontory south of Dingle Bay extends east and west from the Lakes of Killarney, north of Mac Gillicuddy's Reeks, by Lough Caragh, and north of Cahirciveen to Doulus Head on the west coast; a small outlier occurring from the west of Carrantuohill, to the east of Cummeennapeasta, which forms the summit of the reeks; and again on the south, it occupies the valley of Kenmare, on both sides of Kenmare Bay, as may be seen from the section which I have prepared across the Dingle district to the valley of Kenmare; and it may be said to surround the Glengarriff grits on every side: these rocks again occurring between the Old Red of the south shore of Kenmare Bay, and that of the north shore of Bantry Bay.

The grits which derive their name from the latter district, where they occur in a typical form in the neighbourhood of Glengarriff, being distinguished on my Geological Map by a special letter and colour, consist of greenish and brownish sandstones and conglomerates, alternating with reddish-brown, purple, green, and reddish-gray slates, identical in character with the Glengarriff grits of the Dingle promontory; and they may be seen conforming in innumerable convolutions (though not presenting so much vertical disturbance as those of Dingle), to the Old Red Sandstone at Mac Gillicuddy's Reeks, also near Lough Caragh; and thence extending to the east of it, through the Gap of Dunlo, towards Mucross Lake and Torc Mountain. Again, on both sides of the valley of Kenmare, and southward by the Priests' Leap, to the Old Red Sandstone north of the Coomhola River, in all which cases, there is an almost insensible gradation of the one rock into the other, with nothing to mark the passage beyond the colour of the two series of rocks, and the predominance of reddish-gray sandstone strata towards the top of the underlying grit series.

In endeavouring to render these inharmonious facts as consistent as possible, and to form some sort of definite idea respecting them, I brought to my aid the speculation, which though perhaps not sufficiently satisfactory, I may still offer for as much as it is worth: namely, that we had in the Glengarriff rocks, south of Dingle Bay, a set of strata still higher in the series than those of Dingle, and that, in consequence, as we passed southward, the sequence of the grit strata became more complete. I must, however, confess that it appears to me, at present, that

our path will remain rugged and thorny, notwithstanding every attempt at solution.

In the commencement of my communication I referred to a certain analogy which might exist between the reddish-brown rocks, which conform to the Silurian of the north of Ireland, and certain rocks of the south, which it will now be seen are the Glengarriff grits; both occupy a position unconformable to the overlying rocks, and conformable to the Silurian beneath (at least as far as Dingle is concerned); and I may remark that this is the case, whether the Silurian rocks are upper or lower. Then again, without attaching undue importance to it, a consideration never to be overlooked is, that their lithological composition is not dissimilar, consisting, as both do, of reddish-brown sandstone, brecciated conglomerates, reddish and occasionally green shales with calcareous beds; though in the northern rocks the brownish-red colour prevails, the greenish strata being less frequent. We have also interstratifications in both of beds having an igneous origin, the volcanic ash of Sir H. De la Beche; and though the analogy fails in regard to the typical Glengarriff grits, inasmuch as the northern rocks cannot be compared with them, in respect to the conformity of the latter with the true Old Red Sandstone (as probably no equivalents of this formation occur in any part of the north of Ireland); yet, notwithstanding this, I should say we have a double case in favour of the probability that the Glengarriff rocks will rather be of Silurian than of Devonian age, and I think that it will at all events be admitted, that however the case may ultimately be decided, yet that I was sufficiently justified in the classification, which I have made on my Map, of the Glengarriff grits of the two more southern promontories, as well as those of the peninsula of Dingle, especially in the absence of fossiliferous evidence, and in the presence of the formidable inconsistency in position which I have endeavoured to explain. Indeed, as I before observed, whatever they may be, it will be impossible to class them with the Devonian series, at least so long as that term remains as a synonym of Old Red Sandstone. I may further be allowed to say, that in the analogy which I have endeavoured to establish between the rocks of the north and those of the south of Ireland, I am not to be understood as punctiliously asserting exact identity in their position, the brownish-red rocks of the south being possibly higher in the series than those of the north, my argument being, that both are of Silurian age (at least, as that term has been hitherto understood), whether to be classed, the one with the upper, and the other with the Lower or Cambro-Silurian.

As a short and striking exemplification of the difficulty presented by these rocks, I might suppose the case of two observers acting independently, who subsequently enter into conference relative to the investigations which each had made. One of the parties, who had examined the district north of Dingle Bay, would, I should say, think he had an irresistible case in favour of the Silurian age of these rocks, while the other, whose observations had been limited to the district south of the bay, would as strongly maintain their Devonian character. Upon a

comparison of notes, each, though agreeing as to their identity, might find them chameleon-like, constantly eluding his grasp; till an umpire, arriving from a recent examination of the northern or Pomeroy strata, might decide in favour of the first, or perhaps, equally undecided with both, might offer a new and independent solution. In the absence of fossiliferous evidence, however, I fear we must quietly await the slow accumulation of demonstrative facts.

I cannot here pass over a fact which seems to me to be of importance in the consideration of the question before us, and that is the interstratification with the Glengarriff grits, in common with the schistose Silurians of the east of Ireland, as well as with those of Wales (even though these latter be of lower or Cambro-Silurian age), of the ash beds of Sir H. De la Beche, and of the felstone of Mr. Jukes. These, I believe, are not only identical in lithological character,* but are also referrible to one, extended, no doubt, but still one period of igneous action, in which opinion I am happy to find that my friend Professor Haughton fully concurs; and if so, will it not follow from the theory of their contemporaneous origin with the aqueous rocks, with which they are interstratified,—even though a lengthened period may have intervened between the formation of the upper and lower igneous beds,—that the Silurian rocks across the country, with which I would connect the Glengarriff grits, are also attributable to one extended epoch of sedimentary action, even though a similar lengthened period may have intervened between the deposition of the upper and lower, or Cambro-strata; their separation from unconformity not having been hitherto ascertained by any observations made in Ireland.

In conclusion, I can only say that the principal object which I have had in view in bringing this communication before the Society was for the purpose of assisting a discussion by which we might arrive at some reasonble and satisfactory conclusion in regard to a question which I consider to be of the utmost importance in the advancement of our science, and in which Irish geologists are especially interested.

Professor Haughton stated that in the course of his investigations, both in England and Ireland, as well as on the Continent, he had had ample opportunities of judging of Mr. Griffith's general views, and he had long coincided with his subdivision of the Carboniferous System, having paid much attention to the plants which had been alluded to, and he was happy to find that most of the statements which he had published had been confirmed by that eminent authority, M. Brongniart. He was glad to find that his friend Mr. Jukes also entertained the same views, and he thought, with Mr. Griffith, that the derivative character of the Glengariff Grits was not a sufficient ground for the separation of those

* See Professor Jukes' note to Mr. Foot's paper "On the Trappean Rocks in the neighbourhood of Killarney," vol. vii., Proceedings of the Geological Society of Dublin, page 172.

SECTIONS TO ILLUSTRATE MR GRIFFITH'S PAPER

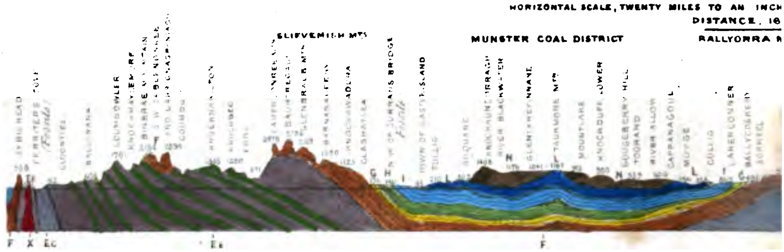
SECTION IN AN EASTERN AND WESTERN DIRECTION, FROM THE GRANITE OF BLACKSTAIRS MOUNTAIN

SHOWING THE RELATIONS OF THE SILURIAN, OLD RED SANDSTONE AND CARBONIFE

AND ESPECIALLY EXHIBITING THE RELATIVE POSITIONS OF THE SEVERAL SER

HORIZONTAL SCALE, TWENTY MILES TO AN INCH

DISTANCE, 16



U – *Granite.* X *Greenstone dikes.* EA – *Schistose Silurians.* EC – *Fossiliferous Silurian slates and gri with red, brownish, green or purple slate. (Glengarriff Grits,? Silurian).* F – *Old Red S Carboniferous Slate, or Lower Limestone shale, (Fossi*

Not

The colours and letters with those which have been adopt

SECTION FROM BRANDON BAY IN A NORTH EAST AND SOUTH WEST DIRECTION, THROUGH THE

SHEWING THE RELATIONS OF THE GLENGARIFF GRITS AND THE OLD RED SAN

HORIZONTAL SCALE, FIVE MILES TO AN INCH.

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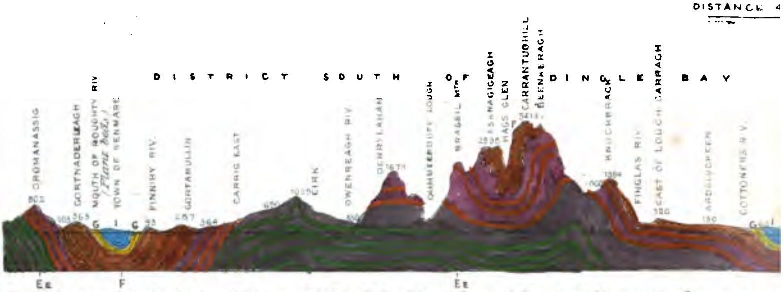


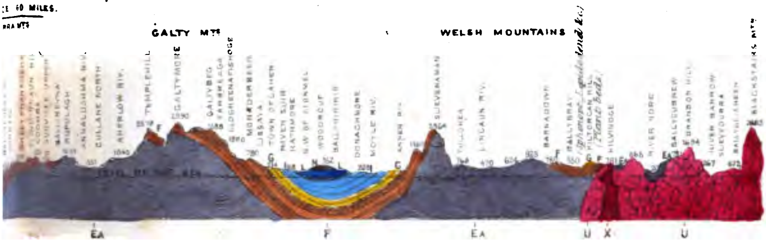
E – *Silurian black slates of Annascall.* EE – *Chloritic or brownish red grits or conglomerates, rian).* F – *Old Red Sandstone, shale and conglomerate.* G – *Yellow Sandstone with shale, (Fla*

Forster & Co. Li

PLATE V.

... ON SEDIMENTARY ROCKS IN THE SOUTH OF IRELAND.

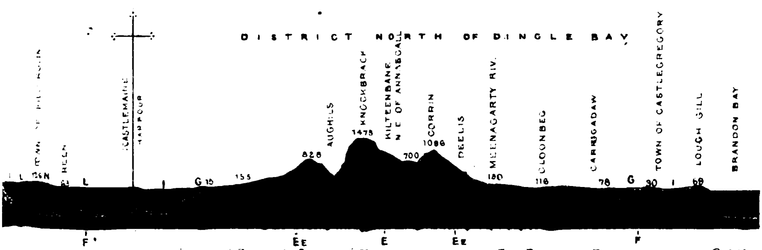
... THE COUNTIES OF WEXFORD AND CARLOW, TO SYBIL HEAD ON THE WEST COAST OF THE COUNTY OF KERRY,
... OUS ROCKS OF THE MIDLAND DISTRICTS OF THE SOUTH EAST OF IRELAND;
... OF STRATA, WHICH OCCUPY THE DISTRICT OF THE PENINSULA OF DINGLE.
... VERTICAL SCALE, TWO MILES TO AN INCH.
... 60 MILES.



... EE_Chloritic or brownish red grits or conglomerates, occasionally alternating ... sandstone, shale and conglomerate. G_Yellow Sandstone with shales, (Plant beds). H_ ... I_Lower Limestone L_Upper Limestone N_Lower Coal Series.

Note.
... of reference correspond ... for the Geological Map of Ireland.

... BAY OF KENMARE, TO DROMANASSIG SOUTH OF THE ROUGHTY RIVER IN THE COUNTY OF KERRY,
... SANDSTONE, WHICH OCCUPY THE PROMONTORIES ON BOTH SIDES OF DINGLE BAY.
... VERTICAL SCALE, ONE MILE TO AN INCH.
... 40 MILES.



... occasionally alternating with red, brownish, green or purple slate, (Glengariff Grits? Silurian beds) I_Lower Limestone. L_Upper Limestone. N_Lower Coal Series.

rocks from the Silurian series. He also alluded to the remark made by Mr. Griffith relative to the associated igneous strata, and stated that he had found them to be similar in composition with those of the Welsh and eastern Irish schistose rocks, as would be seen from several analyses which he had some time since laid before the Society, especially noticing those occurring at Beenaunmore, discovered by Mr. Foot, of the Geological Survey; and Mr. Haughton thought that a lengthened continuance of peculiar igneous action during given periods of deposition will argue contemporaneous similarity of sedimentary condition. He had examined the Pomeroy district, and he agreed with Mr. Griffith respecting the interstratified igneous beds; also believing from his own observation, that the strata of the summit of Carrantuohill and of the Hag's Glen were of true Devonian age. He considered that the alleged unconformity between the upper and lower Silurians should be found very universally occurring before it would become entitled to occupy a place beyond suspicion; as mere overlappings or exceptional disarrangements were liable to be substituted for true unconformities; and he founded the claim to which Mr. Griffith's generalizations and reasoning were entitled upon their intrinsic merit, as well as originality, and not upon the prestige of his name or authority, as Mr. Griffith had never presumed upon any adventitious advantages which the well-deserved reputation, and high character which he had so long enjoyed, might confer upon him. Mr. Haughton also stated, that the value of lithological character in the identification of strata ought never to be wholly neglected.

Mr. Kelly adverted to the vertical strata of the Curlew Mountains, and remarked upon the occurrence of Silurian fossils in them, considering that they were similar to those of the Pomeroy, Clew Bay, Killary, and Glengariff districts. He stated that he could see nothing in Mr. Griffith's paper with which he could disagree, except that, in his opinion, the Old Red rocks of Carrantuohill were not separable from the underlying series; he, however, should say, that the views which he had just heard read were those which Mr. Griffith had always consistently maintained.

Professor Haughton then exhibited a fine specimen of the head of *Oreodon Culbersoni* from Nebrasca, U. S. A., accompanying the exhibition with general explanatory remarks upon the genus; and, in the course of a discussion which ensued, Dr. Carte, and the Director of the University Museum, made some observations upon the general characters of the genus Sus.

The Society then adjourned its meeting to the second Wednesday in December.

WEDNESDAY EVENING, DECEMBER 9, 1857.

Lord Talbot de Malahide, President, in the Chair.

The Society met in the New Museum Buildings, Trinity College, on the above date.

The proposed alteration in the By-Laws was adopted by the Meeting.

The following gentlemen were then admitted as Members of the Society:—

Robert Reeves, Esq.; Richard Dowse, Esq.; William J. Welland, Esq.; Rev. Joseph Carson, D. D.; Rev. Thomas Stack; Rev. Eugene O'Meara; George Bolton, Esq., Jun.; W. H. Baily, Esq.; John Gordon, Esq.

The following gentlemen were admitted as Associate Members for the Session 1857-8:—

W. B. Brownrigg, Esq.; W. D. Babington, Esq.; M. S. Green, Esq.

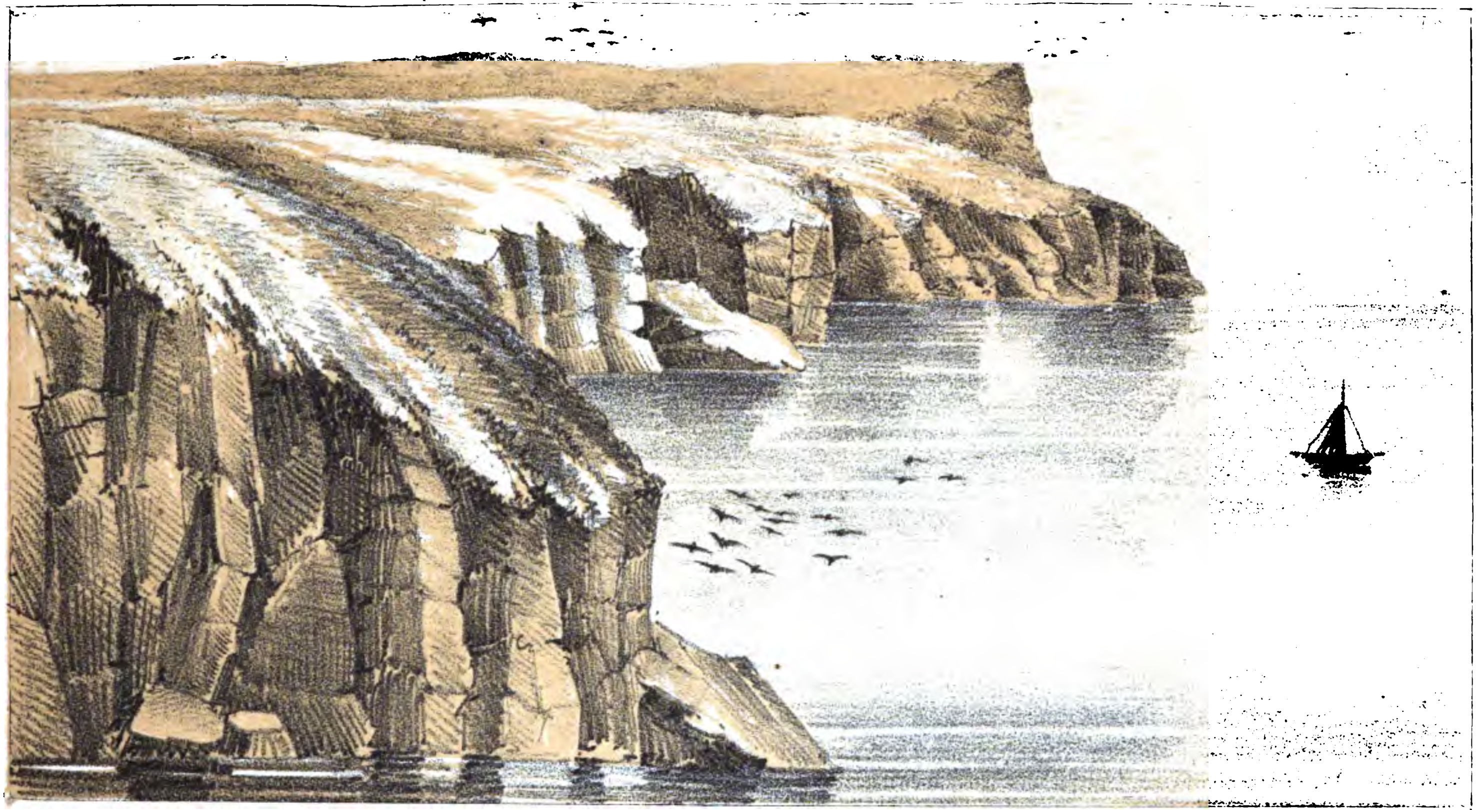
Mr. Haughton then read to the meeting his paper on the "Cleavage and Joint Planes of the Old Red Sandstone Conglomerate of the county of Waterford," which was illustrated by several diagrams and maps, showing the construction of the Conglomerate. Plate I. represents the general appearance presented by the vertical joint and cleavage planes in the conglomerate cliffs near Dunmore East; these planes completely mask the bedding of the rock, which is nearly horizontal; and give the cliffs a semi-columnar structure which is very remarkable.

In Plate II. is represented one of the singular effects of this columnar-jointed structure, in the formation of a natural stone cross "made without hands," which, seen from the sea, bears a striking resemblance to some of the ruder forms of ancient stone crosses found in Ireland and other countries. Mr. Haughton mentioned some of the principal results he had obtained from the discussion of 345 observations made by him on the cleavage and joint planes, and gave an outline of what he conceived to be the correct mechanical theory applicable to the discussion of such observations; and concluded by stating that, as it was his intention to lay the results, in detail, before the Royal Society, he should not trespass further on the time of the Geological Society than to lay before them the general results he had already described.

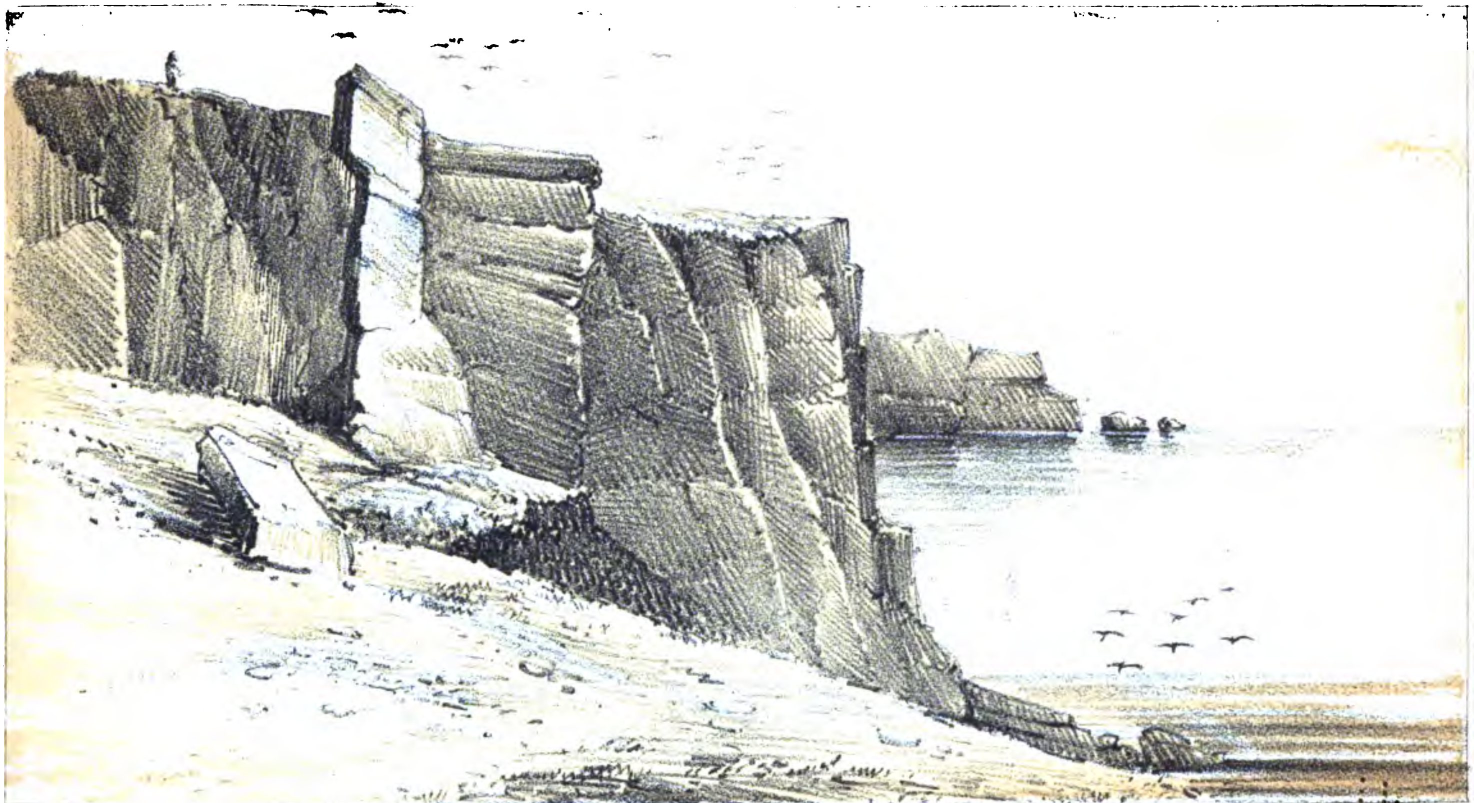
Mr. Du Noyer confirmed, from his own observation of the joint planes in the Conglomerate at Sybil Head, county of Kerry, some of Mr. Haughton's observations; particularly with respect to the complete predominance which the laminated cleavage structure of the Conglomerate acquired over the planes of bedding.

Mr. Kelly said he believed that Waterford Harbour formed a kind of boundary between rocks with cleavage and rocks without it; he meant the upper Palæozoic rocks only. The Carboniferous Slate, what little there is of it at Porter's Gate, is not cleaved—or very little. Their equivalents at Clonea, near Dungarvan, are highly cleaved. It is a problem why should there be such a difference east and west of Waterford Harbour. The red sandstones on both sides of it are at sea level, at Templetown and Dunmore, at Ballyhack and Passage; and yet here is the great north and south line of division. An east and west line might be drawn from Waterford, through Clonmel, to Castlemaine. Very little cleavage in the upper rocks north of this line. Very much, all to the south of it.

The polar influence in producing cleavage must give way. It is



RED HEAD, Co. WATERFORD, FROM PORTALLY HEAD.
January. 1857.



NATURAL STONE CROSS, AT SWINY HEAD, Co. WATERFORD.
January. 1857.

not easy to see, either, how the mechanical theory can be proved, for there is both cleavage of rocks and distortion of fossils. When a pebble of conglomerate was split, the whole rock was hard. When a fossil was distorted, the rock was soft. Were there two periods of this kind; or was distortion of fossils connected with cleavage of rocks at all? In fact, are they parts of the same thing?

Professor Haughton said that he was not unaware of the difficulty suggested by Mr. Kelly; it had occurred to himself at the very outset of his investigations, and he felt disposed to cut the Gordian knot by denying that the Conglomerate was hard when cleaved and jointed. According to his idea, the cleavage took place in the planes of greatest pressure, and this pressure, acting even upon a soft bed of wet, loose gravel, would develop a *latent structure* in this mass, including its quartz pebbles, predisposing them to divide cleanly along the planes of maximum pressure.

ON THE IGNEOUS ROCKS OF ARKLOW HEAD, BY J. BEETE JUKES, M. A., F. R. S.

THE headland immediately south of the small town of Arklow, near the borders of Wicklow and Wexford, has long been pointed out by our old and respected friend, Mr. Griffith, and others, as containing a very interesting assemblage of igneous rocks, forming, as it were, an epitome of those generally found in the Cambro-Silurian district of the S. E. of Ireland. In June last Mr. Griffith read a paper to this Society, containing his notes, written ten years before, on a traverse which he had then just made across this district, and explaining his views of its structure. It had been the mutual hope and expectation of Mr. Griffith and myself to have gone over the ground together, in company with Professor Haughton, and thus to have discussed our different views on the spot, and combined our information, in order to have arrived at a definite conclusion.

This meeting has unfortunately been deferred, and I hope only deferred; but, finding myself able to run down for two or three days during the last week of November, I took the opportunity of doing so, and will now lay before you the result of my own observations, together with a series of specimens collected by myself on the spot.

I may at once say that there is little or no difference between Mr. Griffith and myself as regards the facts of the case, nor is there room for much difference. The principal varieties of igneous rock are well characterized and clearly exhibited. Our views seem to differ chiefly in our notions as to the origin of some of the more obscure and indefinite varieties. Mr. Griffith, I believe, looked upon all the igneous rocks as intrusive, and on the varieties above alluded to as metamorphic; while I, in accordance with the views first clearly put forth by the late Sir H. De la Bêche, and afterwards abundantly elucidated by the work done by the officers of the Geological Survey, both in Wales and Ireland, — allowing fully the intrusive character of some of the igneous rock,— believe that intrusion to have taken place during the Cambro-Silurian

period, while the rocks were yet undisturbed,—and that other varieties of those rocks were poured out as molten sheets at the surface either in air, or under water, accompanied by those mechanically transported ejectamenta, or debris, which we call "ash;" there being every gradation from those igneous materials into purely aqueous slates and gritstones.

The intrusion of the first-named must unquestionably have been accompanied by a certain amount of metamorphic effect on those rocks with which they came in contact; neither are the contemporaneous traps and ashes always devoid of metamorphic characters, since subsequently intrusive rocks would exercise a more marked effect on these than on purely argillaceous or arenaceous rocks. They may have in many instances partaken both of a local metamorphosis, derived from the contact of intrusive rocks, and also of a more general metamorphic effect, which may have either been the result of a long continuance of the elevated temperature which they would attain to when buried under several thousand feet of other rock, or, perhaps may have been the effect of mechanical pressure, or of chemical actions and reactions, which may or may not have been accompanied by heat.

Viewed from this point, the problem becomes a very complex one, since we have a set of rocks, to begin with, of a very various and complicated character, affording almost every gradation from a molten rock to a mud, of the deposition and formation of which we have to unravel the history, to determine, first, which were contemporaneous, and which intrusive; secondly, of the contemporaneous, to discover which flowed as molten sheets, and which were deposited as "ashes" blown into the air, or as fragments worn by the water from previously consolidated masses; and thirdly, of the intrusive we have also to inquire which were erupted previously to, and which subsequently, to the formation of the contemporaneous ones.

We have then to consider the various conditions in which those igneous rocks, together with their associated aqueous deposits, have been placed since their formation,—to take into account that they have been buried many thousand feet deep in the earth, and subsequently re-elevated and exposed at the surface in consequence of the removal by erosion and degradation of those thousands of feet of other rock which had covered them. We have to inquire whether any of the intrusive igneous rocks were injected during any of those subsequent periods of elevation and depression, and, if so, which they were, and how they differ from the intrusive rocks that originally existed in the locality.

Difficult, however, as the problem thus stated may appear, it seems to me that its very difficulty gives it an interest and a charm which was wanting in the previous views taken both of these and of igneous rocks in general. There is a varied history to be learned, a complicated puzzle to be unravelled, and our curiosity thus becomes awakened and aroused, and every step made in advance in the process of investigation becomes watched with an interest that would not be felt in a mere dry detail of matters of fact.

It is for this reason that I have ventured to-night to endeavour to

lead you over the same ground which my valued friend, Mr. Griffith, formerly tracked for you, well knowing that no one will be more ready than himself to hail with pleasure any true additions to our knowledge of facts or any well-grounded extension of our theoretical opinions.

The craggy eminence known as Arklow Rock is about two miles south of the town of Arklow. Its summit rises to a height of 411 feet above the sea, from which it is a quarter of a mile distant, and forms nearly the southern termination of an elevated rocky tract of ground about a mile in length from north to south, and the same distance from east to west As soon as the ground sinks on the land side to the level of 150 feet above the sea, or thereabouts, the rocks become concealed by the Pleistocene deposits which cover all the lower parts of the adjacent country. Of these, the well-known "Marl" is the most conspicuous portion.

The district is divided into two townlands, "Rock Little" on the west, and "Rock Big" on the east. "Rock Little" has a craggy knoll rising to a height of about 250 or 300 feet, which is composed of black and dark gray slate with some gritstone. In Mr. Wyley's notes Graptolites were said to have been found in this. The strike of these slates is about N. 30 E., while that of the cleavage is E. 30 N., the dip of the latter in one place certainly was westerly at 70°; but that of the slates was not so easily determined, from the smallness of the exposed portion of rock. Everybody of experience in slaty countries knows how little dependence can be placed on observations of bedding made on surfaces of a less depth than twenty or thirty feet. At one point the dip of the beds seemed to be westerly at 70°, at another point the beds appeared to be vertical; the strike, however, was pretty constant and uniform, and showed the above difference of about 30° between that of the beds and that of the cleavage, but as the observations were taken in separate spots they are not of much value. When the cleavage was well marked, the bedding lines were obliterated; where the bedding could be determined by the occurence of grit bands, there appeared to be no cleavage, or, if there were, it coincided with the bedding. These little difficulties are of common occurrence.

In the lower ground to the west of the slate ridge are large quarries opened for the purpose of getting a granitic rock of the kind which I propose to call Elvanite. One band of this, in which there are two quarries opened, appears to be at least twenty yards wide, and to run about N.N.E. in the strike of the beds; but on the west side of it, in the lower part of the quarry, three or four smaller and rather irregular veins, of ten to twenty feet only in width, run in a more easterly and westerly direction about E. 35 N. or W. 35 S., as if they branched out of the larger mass, a point which further excavation was required to determine. The slate near these veins was slightly altered, much shattered, and stained of a dark-brown colour, but this alteration could not be perceived at a greater distance than a few feet from the dyke, and at ten yards from it the slate was quite unaltered. The smaller granite veins were composed of a pale-yellow compact or finely granular rock, some-

times rather friable and earthy, appearing like a somewhat decomposed mixture of granular feldspar and quartz. The larger mass was a distinctly crystalline aggregate of feldspar and quartz, with, in some parts, small crests and little detached flakes of white or green mica. It thus formed a perfect granite occasionally, though its general appearance in the quarry was hardly that of true granite, and it required a close inspection of a fresh surface to assure one's self that it was so. It was much jointed in many directions, but large cuboidal blocks were not unfrequent. When broken open, these were often seen to show signs of weathering internally to a depth even of eight inches or a foot, and even when taken from the heart of the quarry. The central nucleus or core of these blocks was a pale greenish-gray, while that core was surrounded by bands of yellowish and reddish-brown, conforming in outline to the external margin of the block, and getting darker as they approached it. This is a very common character in most of the elvan dykes of Wicklow and Wexford, but is one that is not so often seen, scarcely ever to the same extent, in larger masses of true granite. Is it owing to the presence of iron, or some other ingredient which the veins have derived from the masses of other rock which they traversed?

About thirty yards east of the quarries in this Granite or Elvanite, blocks apparently *in situ* appeared above ground of a totally different rock. This was a highly crystalline greenstone, with tabular crystals of feldspar, sometimes half an inch long, but generally smaller, though still distinct, and of a white or pale-green colour, interlaced with crystalline granules of dark apple-green hornblende, and a black lustrous mineral, which is probably another variety of hornblende. Yellow iron pyrites also occurs in small cubical crystals. It was intensely hard, and the blocks were so massive, and weathered into such rounded forms, that it was impossible to detach any but small chips from them. A few yards east of the line in which these blocks occurred, the greenstone appeared to become of a finer grain as it approached the slate. The slate itself near the greenstone was very hard, and had a flinty appearance, probably due to the influence of heat; but this only extended for a few feet, the mass of the slate being quite unaltered.

After crossing the slate ridge to the east, crystalline greenstone again appeared, occupying all the south-eastern slope of the hill of Rock Little, and there was one narrow belt of ground running across the strike of the slates, in which no fragments of slate were to be seen at the surface; but blocks of greenstone did appear. It is possible, then, that here was a greenstone dyke cutting across the slate, and connecting the greenstone on the east with that on the west. If so, it must be very narrow, not more, certainly, than ten yards, as slate appeared again in mass immediately to the north-east of this band.

This greenstone, which occurs in considerable mass on the south-east of the hill of Rock Little, continues down into the small valley which runs between Rock Little, and Rock Big, and the first rock seen after crossing that valley is also greenstone of a similar character. It is probable, therefore, that the valley has been excavated in the greenstone,

as it certainly is further north, where the little brook at the bottom of it falls over ledges of greenstone.

It might at first sight, perhaps, seem unlikely that so hard and so tough a rock as this greenstone would be excavated rather than the cleaved slates which form the hill on one side of it, or the more brittle felstones, &c., which form the loftier hill on the other side. It is, however, a very common occurrence among these old Cambro-Silurian rocks, both in Ireland and in Wales, and elsewhere, that the greenstones have suffered degradation rather than the slates and felstones. The reason of this is, probably, that although very hard and very tough, they are in the first place more open, from their mineral constitution, to the slow action of the weather than the slates and felstones. The silicates of lime, &c., which they contain become converted into carbonates, as may be seen by their effervescing with acids along their cracks and crevices, and at the inner margin of their decomposed part; and these carbonates are then dissolved, and the disintegration of the rock is the consequence. In the second place, greenstones, like basalts and some other igneous rocks, have a concealed internal spheroidal structure, which weathering develops by removing all the angular corners and prominences, and the weathered blocks are, therefore, more easily set in motion by the action of breakers and currents than the more permanently angular felstones, or the flat and shingly slate rocks. During the passage of the land, then, through the upper surface of the sea, at its various periods of slow elevation and depression, it is natural to suppose that the greenstones may have in many instances been more acted upon by denuding forces than the adjacent slates or felstones.

The greenstone now described runs along the whole western side of Rock Big, stretching up the western flank of Arklow Rock, nearly to the summit. Near its boundary, and in some other places, it is fine-grained, and sometimes almost earthy in appearance, though still hard; but in its more central portion it is very crystalline, showing large glittering faces of the black lustrous mineral before mentioned.

The eastern boundary of this greenstone runs in a nearly straight line, about N. N. E. and S. S. W., parallel to the general strike of the rocks, and it is very well defined, and determinable within five or six yards, at several points within the space of a mile.

Parallel to this boundary a band of a very remarkable rock occurs, about 150 yards in width, and running right over the summit of Arklow Rock from one extremity of the district to the other. This rock would be generally called a feldspar, porphyry, or a porphyritic felstone, and over the greater part of its course it would be improper to give it any other name. It consists of a dark gray, or greenish-gray base, full of small white crystals of feldspar, about one-fourth of an inch long; the base or paste, which is quite smooth and compact, likewise exhibiting here and there brilliant facets of crystals of feldspar of the same colour as itself. The white opaque crystals of feldspar are sometimes rather irregular in form, though they do not exhibit any discoloured marks of weathering, nor much appearance of their angles having been worn or

rounded. Notwithstanding the completely porphyritic appearance of this rock where it was first seen, there was a certain indefinable character about it that reminded me of other rocks both in Wales and Waterford, which had been at first taken for porphyry, but were eventually found to be of mechanical formation, and I therefore searched carefully along the band in order to arrive at a true estimate of its character. When traced down to the cliffs at the north end of the headland, the rock was well exposed, and part of it was there clearly seen to be conglomeritic in structure, containing small rounded pebbles of vesicular trap, and rounded and angular fragments of felstone and slate. In one part these were arranged in distinct layers, exhibiting a well-marked lamination striking N.N.E., parallel to the strike of the country, and evidently the result of stratification, and even the white opaque crystals or crystalline fragments of feldspar were in another part likewise arranged in lines and layers, having the same strike as if they had been, not *innate* crystals produced where they are now found, but crystals brought either by water or air and deposited along with the paste in which they were embedded. Some parts of this rock in the quarries on the beach lost altogether the brecciated and conglomeritic character, consisting of dark gray felstone, quite smooth and compact, with little facets of *innate* crystals scattered here and there. The rock, however, retained a streaky or grained structure, in consequence of the parallel arrangement of small layers of different colours and slightly different texture. This grain often exists in truly molten rocks being caused by the flowing of the mass while in a pasty condition; or it may be the mark of an altered ash.

Immediately over these rocks, or to the east of this band, on the coast, is a distinctly stratified rock, about ten feet thick, an ashy shale with interstratified fine-grained grits, or thin layers of felstone (I could not quite determine which), that dipped to E. S. E. at 50°; above that occurred a band about twenty yards wide, of columnar greenstone, the columns of which lay at right angles to the stratification of the slate below, and had both above and below them a thin band of earthy-looking greenstone, and over that were white felstones and slates, apparently interstratified, but much twisted and contorted, large roundish masses of felstone being partly enveloped by beds of indurated shale. Other masses of greenstone appeared obscurely connected or intertangled with them. These irregular and confused rocks occur on each side of the Arch Rock, an overhanging mass which has now fallen down, and beyond them, along the shore to the southward, we come upon a large mass of pure white felstone.

Tracing the porphyritic band at first alluded to, from the coast over the hill, I found exactly in its strike, on the north slope of Arklow Rock, not far from a cottage occupied by George Prestwich, a mass of very coarse conglomerate, the base of which resembled the porphyry, and had both the opaque feldspar crystals and those which seemed certainly *innate* (or produced in the mass), while the whole rock was crowded with pebbles of many other rocks, principally felstone, from the size of the first

downward. The stratification of this conglomerate appeared to coincide with that of the country generally, the strike being N. N. E., and the bedding at a high angle.

Just behind George Prestwich's the porphyry is quarried, and it was here that I procured the specimens, in one of which you will perceive an embedded pebble of felstone of the size of a nut, notwithstanding the crystalline porphyritic and apparently molten character of the rock.

East of this band there extends another band parallel to it, and about 100 yards in width, right across the hill, composed of felstone varying from a rather dark-gray through a pale green to a nearly pure white, having the compact smooth texture usual with this rock, but exhibiting every here and there small glittering facets of crystals of feldspar.

Over, or to the eastward of this, there appear to be some beds of a kind of ash, either felstone or greenstone, or having both characters intermingled, containing at one place on the coast veins of felstone, which are probably the ends of small contemporaneous flows of that rock.

East of these again at the Hanging Stone, and at all places N. N. E. and S. S. W. of it, is a band of greenstone about 80 or 100 yards wide, and very well exhibited along the cliffs. This greenstone is of a finer grain than that before mentioned, but is a well-characterized greenstone. It is remarkable that both in this and in other rocks of the district there is a much greater proportion of iron pyrites in small detached cubical crystals than is usual in such rocks.

Proceeding along the cliffs south of the Hanging Stone, when about a quarter of a mile south of it, the greenstone gradually becomes earthy and friable, and passes into a flaky sort of greenish or yellowish ash, which shortly becomes distinctly stratified, and passes up into thin beds of fine-grained slate and gritstone, and these are shortly overlaid by a bed of coarse conglomerate, twenty or thirty feet thick, over which is more thick, massive ash, and then a small exposure of dark gray compact felstone terminates the section.

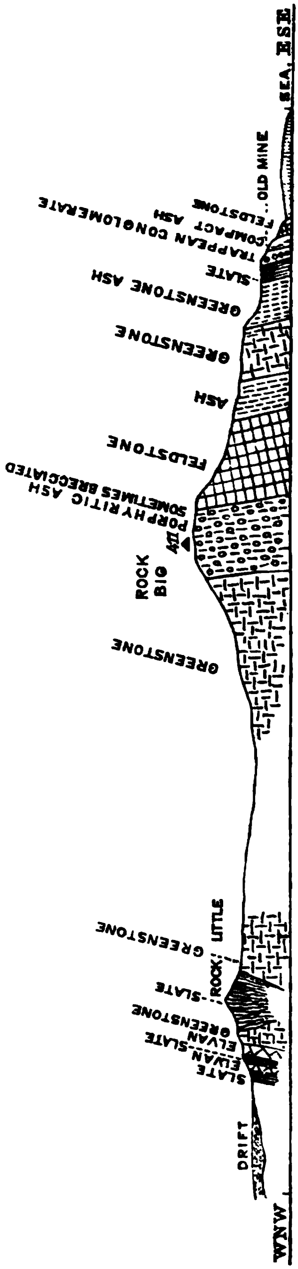
These clearly stratified rocks dip E. S. E. at 70° or 80°. The conglomerate is full of well-rounded pebbles of trap and fragments of slate, some of the traps being compact felstone, others quite vesicular, almost pumiceous in appearance, such as I did not see *in situ* anywhere. It had very much the aspect, except from its highly inclined position, of one of the beds of volcanic breccia and conglomerate one so often sees about recent and active volcanoes; and it occurred to me that in these pebbles of vesicular trap we might have preserved the only fragments of the more superficial parts of the flows of molten matter which were produced at the time of the igneous outburst, the compact felstones being the lower part of those molten streams.

As a general result, then, of this description, we may state that here, as in many other localities of the Cambro-Silurian district of the south-east of Ireland and the opposite coast of Wales, volcanic outbursts and eruptions were taking place in the bed of the sea, in which those muds

and sands were being deposited that we now recognise as fine-grained slates and gritstones. That from these active volcanic vents, flows of molten rock were taking place, some of which, being more purely felspathic, consolidated into felstones; others, having the materials for the formation of hornblende mingled with the felspathic base, produced greenstones. Both kinds were accompanied by mechanically formed ashes and conglomerates, just as the trachytic and doleritic lavas of the present day are accompanied by tuff and peperino, and volcanic breccias. It follows, of necessity, that these contemporaneous sheets of trap had their origin somewhere in intrusive pipes, veins, and larger masses, proceeding from the interior towards the surface; and it is probable that the contemporaneous sheets of greenstone proceeded from masses of intrusive greenstone, and that the felstones proceeded from dykes and veins of crystalline felstone; in other words, from a crystalline aggregate of quartz and feldspar, which is, in fact, that variety of granitic rock which I have called Elvanite, and which, whenever it contains a micaceous mineral as a constituent, becomes true Granite.

We must, therefore, look to granite veins and intrusive masses as the deep-seated portion of that mass which, when poured out at the surface, becomes felstone—a rock which has the same feldspar and quartz in a pasty condition, that in the Elvanite are crystallized out. We may then fairly suspect that many of the numerous elvan dykes and veins, and some of the granite masses most closely agreeing with Elvanite, were in fact the deep-seated roots, as it were, from which the felstones have proceeded. Although, then, these dykes and

Section through Arklow Rock.



Scale, both vertical and horizontal, 6 inches to 1 mile.

masses of granite are really intrusive into Cambro-Silurian rocks, they yet belong in reality to the Cambro-Silurian period, being older than the beds which lie above the felstones, though, of course, newer than the parts in which they themselves lie. These are conclusions which I drew from my examination of parts of the county of Wicklow and Wexford, three or four years ago, and which every subsequent examination has tended to confirm.

In the present instance I should look upon the slates of Rock Little as the lowest beds of the district, and, therefore, older than the traps of Rock Big; and I believe the larger masses of these trappean rocks to have been formed in the order of their succession from west to east,—the porphyritic ash having been first formed; then the sheets of felstone, and their accompaning ashes, then the very regular band of greenstone of the Hanging Stone, followed by the deposition of several beds of greenstone ash, those by the formation of beds of argillaceous mud, and afterwards by the thick beds of conglomerate, derived probably from a portion of some of the previously consolidated traps that had become exposed to the action of a current. Other beds of ash and other flows of felstone then took place, as indicated by the highest beds of the section. If the metamorphism that has subsequently produced the *innate* crystalline structure in the porphyritic ash be attributable to the greenstone immediately alongside of it, then, probably, the whole mass of the greenstone on the west flank of Rock Big, and all that of Rock Little, is of intrusive origin, and is newer than the felstones, &c., to the east of it. It is nearly certain that the intrusion of the elvan (or granite) dykes on the west side of Rock Little took place subsequently to the production of the greenstone, both because the greenstone nearest to them is more highly crystalline than the rest, as if it had been remelted; and because in one corner of one of the lower quarries of Rock Little I found a small vein of Elvanite cutting through a mass of greenstone, apparently part of the general mass of the neighbourhood. The elvan, then, must be looked on as the newest rock of the district.

It would follow, however, both from the highly crystalline structure of the elvans and greenstones of Rock Little, and from their boundaries being parallel to the general strike of the country, that their intrusion took place while the beds above them were yet horizontal and undisturbed, either by elevation or denudation; and that their present situation is due to their having partaken in the general movement and general erosion that has effected the whole country, and impressed upon it the general strike of its rocks, and the general outline of its surface.

It has been already stated that the metamorphic effect of any of these rocks is very slight, and confined strictly to their immediate neighbourhood, disappearing at a distance of a few feet from them in the aqueous rocks, and at that of a few yards in those igneous rocks which have been altered.

I believe any disturbing effect consequent on the intrusion of these igneous rocks to have been as restricted as their metamorphic action; that the intruded rocks were injected as horizontal sheets, gently lifting

and floating up the rocks above them, but not otherwise tilting or disturbing them,—and that the igneous rocks were all there, and all consolidated into their present condition, *before the commencement* of those great movements of elevation and disturbance by which the Cambro-Silurian rocks were tilted and inclined, not only in the south-east of Ireland, but simultaneously over all the British islands, and throughout Scandinavia and the north-western parts of Europe.

Dr. Griffith observed that in a paper recently read to the Society, respecting a visit made by him to Arklow Rock many years ago, he had put forward views somewhat different from, although on the whole reconcilable with, the statement of Mr. Jukes; and expressed his general concurrence in Mr. Jukes's views, although he confessed he felt still disposed to uphold the old-fashioned metamorphic theory.

Professor Haughton asked whether the occurrence of a band of genuine granitic elvans in the centre of the rocks of this district might not render their highly metamorphic condition explicable; whether he considered them to have been originally of simply aqueous, or of trappean ash origin.

Mr. Jukes having replied satisfactorily to the several queries proposed, Dr. Alexander Carte read a paper "On a Jaw and Tooth of Elephas Cliftii, from the Sub-Himalayas."

Dr. Griffith then moved that the marked thanks of the Society be given to the Provost and Board of Trinity College for their kindness in allowing the Society the use of so spacious and convenient a room for their meetings.

Carried by acclamation.

The meeting then adjourned until the second Wednesday in January, 1858.

WEDNESDAY EVENING, JANUARY 13, 1858.

ROBERT MALLET, ESQ., in the Chair.

THE following gentlemen were elected Members of the Society:—Joseph Kincaid, Esq., Herbert-street; Thomas Hampton, Esq., C.E., 108, Lower Baggot-street; George A. Craig, Esq., C. E., 108, Lower Baggot-street.

James Glennan, Esq., Dolphin's Barn, was elected an Associate Member for the Session 1857–8.

The notice of motion from Council was read, viz.:—"Any person residing as above, who shall have paid an admission fee of £5, shall be at liberty, at any time, to compound for his annual subscription by a payment of a further sum of £5."

MR. J. BEETE JUKES read the following paper:—

JUNCTION OF THE LIMESTONE, SANDSTONE, AND GRANITE AT OUGHTERARD, COUNTY GALWAY. BY JOHN BIRMINGHAM, ESQ.

IN few places in Ireland can the junction of the granite with other rocks be seen to greater advantage than immediately about Oughterard.

At the picturesque waterfall, near the town, a series of three or four different sandstones appear overlying the syenitic rock, while they, in turn, are overlaid by the beds of carboniferous limestone. At Derrylaura, about one mile N. W. from Oughterard, a coarse red conglomerate, with rounded pebbles of grey quartz, is found resting on the igneous rock at an inclination of 15°. The division of the two rocks is here far better defined than at the junction near the town, where there appears to be a passage from the sandstone into the syenite. A stream bears along during floods the quartzose pebbles set free by disintegration from the conglomerate; and it is interesting to contemplate the shingle that once rolled on the shores of an ancient sea, now hurried on in the bed of the mountain torrent after its rest of ages. The sandstone here is probably the extremity of a narrow band of that rock that extends under the waters of Loch Corrib to Cong, and rises near that town with a thick covering of its own detritus.

A junction of a different kind may be examined about three miles south from Oughterard, where the beautiful syenitic porphyry abuts against a hornblendic rock, that forms with it a range of hills varying from 600 to above 900 feet in height; from whose summits the greater part of the igneous district of West Galway may be seen, stretching away to the ocean with its sombre covering of heathy moor, and drearily speckled with the leaden tints of its hundred lakes and pools.

I have attempted to show the features of the junction at Oughterard in a plan and diagram section:—

No. 1 is the ordinary limestone, but changing its character at its junction with the sandstone, where it assumes an arenaceous appearance, and becomes full of crystals of calcite.

No. 2 is a bed of yellow sandstone, six feet thick.

No. 3 is also a bed of sandstone, thinly laminated, and full of minute crystals of pyrites, three feet thick.

No. 4 is a bed of quartzose sandstone, four feet thick.

No. 5 is a remarkable rock. It may be called a sandstone conglomerate: but on the surface I found some four-sided pyramids, from two to three inches in height, and more or less perfectly shaped like crystals. These are mineralogically different from the rock itself, and somewhat from each other, assuming in various degrees a syenitic character. They are spotted with pyrites, and contain small crystals, apparently of hornblende. This rock is interesting in a double point of view, as it illustrates the passage of a sandstone into a syenite, and shows a tendency of the latter to form crystalline shapes, which, in this example, enclose smaller crystals of its contained minerals. The pyramids, and, indeed, all the granitic rocks, are covered with a coat of shining black, that reminds one of the incrustations which Humboldt says are found on granites washed by rivers of the torrid zone.

No. 6 is a rock of very varied appearance. In some places it might be called quartz rock; in others it resembles a conglomerate, and in others again it approaches a syenite, into which it finally seems to pass.

The inclination of the stratified rocks increases from 30° at the head of the lower waterfall to 60° at the summit of the upper, and it again

rounded. Notwithstanding the completely porphyritic appearance of this rock where it was first seen, there was a certain indefinable character about it that reminded me of other rocks both in Wales and Waterford, which had been at first taken for porphyry, but were eventually found to be of mechanical formation, and I therefore searched carefully along the band in order to arrive at a true estimate of its character. When traced down to the cliffs at the north end of the headland, the rock was well exposed, and part of it was there clearly seen to be conglomeritic in structure, containing small rounded pebbles of vesicular trap, and rounded and angular fragments of felstone and slate. In one part these were arranged in distinct layers, exhibiting a well-marked lamination striking N.N.E., parallel to the strike of the country, and evidently the result of stratification, and even the white opaque crystals or crystalline fragments of feldspar were in another part likewise arranged in lines and layers, having the same strike as if they had been, not *innate* crystals produced where they are now found, but crystals brought either by water or air and deposited along with the paste in which they were embedded. Some parts of this rock in the quarries on the beach lost altogether the brecciated and conglomeritic character, consisting of dark gray felstone, quite smooth and compact, with little facets of *innate* crystals scattered here and there. The rock, however, retained a streaky or grained structure, in consequence of the parallel arrangement of small layers of different colours and slightly different texture. This grain often exists in truly molten rocks being caused by the flowing of the mass while in a pasty condition; or it may be the mark of an altered ash.

Immediately over these rocks, or to the east of this band, on the coast, is a distinctly stratified rock, about ten feet thick, an ashy shale with interstratified fine-grained grits, or thin layers of felstone (I could not quite determine which), that dipped to E. S. E. at 50°; above that occurred a band about twenty yards wide, of columnar greenstone, the columns of which lay at right angles to the stratification of the slate below, and had both above and below them a thin band of earthy-looking greenstone, and over that were white felstones and slates, apparently interstratified, but much twisted and contorted, large roundish masses of felstone being partly enveloped by beds of indurated shale. Other masses of greenstone appeared obscurely connected or intertangled with them. These irregular and confused rocks occur on each side of the Arch Rock, an overhanging mass which has now fallen down, and beyond them, along the shore to the southward, we come upon a large mass of pure white felstone.

Tracing the porphyritic band at first alluded to, from the coast over the hill, I found exactly in its strike, on the north slope of Arklow Rock, not far from a cottage occupied by George Prestwich, a mass of very coarse conglomerate, the base of which resembled the porphyry, and had both the opaque feldspar crystals and those which seemed certainly *innate* (or produced in the mass), while the whole rock was crowded with pebbles of many other rocks, principally felstone, from the size of the first

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East of these again at the Hanging Stone, and at all places N. N. E. and S. S. W. of it, is a band of greenstone about 80 or 100 yards wide, and very well exhibited along the cliffs. This greenstone is of a finer grain than that before mentioned, but is a well-characterized greenstone. It is remarkable that both in this and in other rocks of the district there is a much greater proportion of iron pyrites in small detached cubical crystals than is usual in such rocks.

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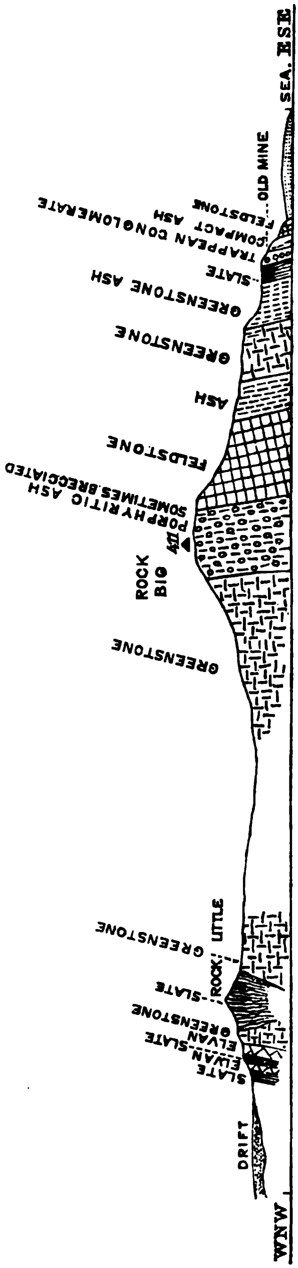
and sands were being deposited that we now recognise as fine-grained slates and gritstones. That from these active volcanic vents, flows of molten rock were taking place, some of which, being more purely felspathic, consolidated into felstones; others, having the materials for the formation of hornblende mingled with the felspathic base, produced greenstones. Both kinds were accompanied by mechanically formed ashes and conglomerates, just as the trachytic and doleritic lavas of the present day are accompanied by tuff and peperino, and volcanic breccias. It follows, of necessity, that these contemporaneous sheets of trap had their origin somewhere in intrusive pipes, veins, and larger masses, proceeding from the interior towards the surface; and it is probable that the contemporaneous sheets of greenstone proceeded from masses of intrusive greenstone, and that the felstones proceeded from dykes and veins of crystalline felstone; in other words, from a crystalline aggregate of quartz and feldspar, which is, in fact, that variety of granitic rock which I have called Elvanite, and which, whenever it contains a micaceous mineral as a constituent, becomes true Granite.

We must, therefore, look to granite veins and intrusive masses as the deep-seated portion of that mass which, when poured out at the surface, becomes felstone—a rock which has the same feldspar and quartz in a pasty condition, that in the Elvanite are crystallized out. We may then fairly suspect that many of the numerous elvan dykes and veins, and some of the granite masses must closely agreeing with Elvanite, were in fact the deep-seated roots, as it were, from which the felstones have proceeded. Although, then, these dykes and



Section through Arklow Rock.

Scale, both vertical and horizontal, 6 inches to 1 mile.

masses of granite are really intrusive into Cambro-Silurian rocks, they yet belong in reality to the Cambro-Silurian period, being older than the beds which lie above the felstones, though, of course, newer than the parts in which they themselves lie. These are conclusions which I drew from my examination of parts of the county of Wicklow and Wexford, three or four years ago, and which every subsequent examination has tended to confirm.

In the present instance I should look upon the slates of Rock Little as the lowest beds of the district, and, therefore, older than the traps of Rock Big; and I believe the larger masses of these trappean rocks to have been formed in the order of their succession from west to east,—the porphyritic ash having been first formed; then the sheets of felstone, and their accompaning ashes, then the very regular band of greenstone of the Hanging Stone, followed by the deposition of several beds of greenstone ash, those by the formation of beds of argillaceous mud, and afterwards by the thick beds of conglomerate, derived probably from a portion of some of the previously consolidated traps that had become exposed to the action of a current. Other beds of ash and other flows of felstone then took place, as indicated by the highest beds of the section. If the metamorphism that has subsequently produced the *innate* crystalline structure in the porphyritic ash be attributable to the greenstone immediately alongside of it, then, probably, the whole mass of the greenstone on the west flank of Rock Big, and all that of Rock Little, is of intrusive origin, and is newer than the felstones, &c., to the east of it. It is nearly certain that the intrusion of the elvan (or granite) dykes on the west side of Rock Little took place subsequently to the production of the greenstone, both because the greenstone nearest to them is more highly crystalline than the rest, as if it had been remelted; and because in one corner of one of the lower quarries of Rock Little I found a small vein of Elvanite cutting through a mass of greenstone, apparently part of the general mass of the neighbourhood. The elvan, then, must be looked on as the newest rock of the district.

It would follow, however, both from the highly crystalline structure of the elvans and greenstones of Rock Little, and from their boundaries being parallel to the general strike of the country, that their intrusion took place while the beds above them were yet horizontal and undisturbed, either by elevation or denudation; and that their present situation is due to their having partaken in the general movement and general erosion that has effected the whole country, and impressed upon it the general strike of its rocks, and the general outline of its surface.

It has been already stated that the metamorphic effect of any of these rocks is very slight, and confined strictly to their immediate neighbourhood, disappearing at a distance of a few feet from them in the aqueous rocks, and at that of a few yards in those igneous rocks which have been altered.

I believe any disturbing effect consequent on the intrusion of these igneous rocks to have been as restricted as their metamorphic action; that the intruded rocks were injected as horizontal sheets, gently lifting

and floating up the rocks above them, but not otherwise tilting or disturbing them,—and that the igneous rocks were all there, and all consolidated into their present condition, *before the commencement* of those great movements of elevation and disturbance by which the Cambro-Silurian rocks were tilted and inclined, not only in the south-east of Ireland, but simultaneously over all the British islands, and throughout Scandinavia and the north-western parts of Europe.

Dr. Griffith observed that in a paper recently read to the Society, respecting a visit made by him to Arklow Rock many years ago, he had put forward views somewhat different from, although on the whole reconcilable with, the statement of Mr. Jukes; and expressed his general concurrence in Mr. Jukes's views, although he confessed he felt still disposed to uphold the old-fashioned metamorphic theory.

Professor Haughton asked whether the occurrence of a band of genuine granitic elvans in the centre of the rocks of this district might not render their highly metamorphic condition explicable; whether he considered them to have been originally of simply aqueous, or of trappean ash origin.

Mr. Jukes having replied satisfactorily to the several queries proposed, Dr. Alexander Carte read a paper "On a Jaw and Tooth of Elephas Cliftii, from the Sub-Himalayas."

Dr. Griffith then moved that the marked thanks of the Society be given to the Provost and Board of Trinity College for their kindness in allowing the Society the use of so spacious and convenient a room for their meetings.

Carried by acclamation.

The meeting then adjourned until the second Wednesday in January, 1858.

WEDNESDAY EVENING, JANUARY 13, 1858.

ROBERT MALLET, ESQ., in the Chair.

THE following gentlemen were elected Members of the Society:—Joseph Kincaid, Esq., Herbert-street; Thomas Hampton, Esq., C.E., 108, Lower Baggot-street; George A. Craig, Esq., C. E., 108, Lower Baggot-street.

James Glennan, Esq., Dolphin's Barn, was elected an Associate Member for the Session 1857–8.

The notice of motion from Council was read, viz.:—"Any person residing as above, who shall have paid an admission fee of £5, shall be at liberty, at any time, to compound for his annual subscription by a payment of a further sum of £5."

MR. J. BEETE JUKES read the following paper:—

JUNCTION OF THE LIMESTONE, SANDSTONE, AND GRANITE AT OUGHTERARD, COUNTY GALWAY. BY JOHN BIRMINGHAM, ESQ.

IN few places in Ireland can the junction of the granite with other rocks be seen to greater advantage than immediately about Oughterard.

At the picturesque waterfall, near the town, a series of three or four different sandstones appear overlying the syenitic rock, while they, in turn, are overlaid by the beds of carboniferous limestone. At Derrylaura, about one mile N.W. from Oughterard, a coarse red conglomerate, with rounded pebbles of grey quartz, is found resting on the igneous rock at an inclination of 15°. The division of the two rocks is here far better defined than at the junction near the town, where there appears to be a passage from the sandstone into the syenite. A stream bears along during floods the quartzose pebbles set free by disintegration from the conglomerate; and it is interesting to contemplate the shingle that once rolled on the shores of an ancient sea, now hurried on in the bed of the mountain torrent after its rest of ages. The sandstone here is probably the extremity of a narrow band of that rock that extends under the waters of Loch Corrib to Cong, and rises near that town with a thick covering of its own detritus.

A junction of a different kind may be examined about three miles south from Oughterard, where the beautiful syenitic porphyry abuts against a hornblendic rock, that forms with it a range of hills varying from 600 to above 900 feet in height; from whose summits the greater part of the igneous district of West Galway may be seen, stretching away to the ocean with its sombre covering of heathy moor, and drearily speckled with the leaden tints of its hundred lakes and pools.

I have attempted to show the features of the junction at Oughterard in a plan and diagram section:—

No. 1 is the ordinary limestone, but changing its character at its junction with the sandstone, where it assumes an arenaceous appearance, and becomes full of crystals of calcite.

No. 2 is a bed of yellow sandstone, six feet thick.

No. 3 is also a bed of sandstone, thinly laminated, and full of minute crystals of pyrites, three feet thick.

No. 4 is a bed of quartzose sandstone, four feet thick.

No. 5 is a remarkable rock. It may be called a sandstone conglomerate: but on the surface I found some four-sided pyramids, from two to three inches in height, and more or less perfectly shaped like crystals. These are mineralogically different from the rock itself, and somewhat from each other, assuming in various degrees a syenitic character. They are spotted with pyrites, and contain small crystals, apparently of hornblende. This rock is interesting in a double point of view, as it illustrates the passage of a sandstone into a syenite, and shows a tendency of the latter to form crystalline shapes, which, in this example, enclose smaller crystals of its contained minerals. The pyramids, and, indeed, all the granitic rocks, are covered with a coat of shining black, that reminds one of the incrustations which Humboldt says are found on granites washed by rivers of the torrid zone.

No. 6 is a rock of very varied appearance. In some places it might be called quartz rock; in others it resembles a conglomerate, and in others again it approaches a syenite, into which it finally seems to pass.

The inclination of the stratified rocks increases from 30° at the head of the lower waterfall to 60° at the summit of the upper, and it again

decreases to 30° at the junction with the syenite; and it is worthy of remark that the planes of the principal joints of the latter at No. 7 display a conformability with the bedding of the former.

a represents the place of a cliff situate in an island not in the line of section, opposite which the rock in the bed of the river exhibits joints *anticlinal* to No. 7. The cliff is formed of a light-coloured syenite with whitish felspar and green hornblende; and *b* shows the position of a cliff on the side of the fall, similar in mineralogical character to Nos. 5 and 6.

The phenomena I have tried to describe seem to suggest that the syenite here was an altered sandstone, elevated at an axis marked by the meeting of the anticlinal planes of the joints; and I consider the rocks at this junction no less worthy of observation on that account, than for the distinctness with which they show the tendency of a rock mass to assume definite crystalline forms under favourable conditions, which in this case might be attributed to the absence of pressure on the sandstone that had previously been stripped by denudation.

Mr. Kelly made some remarks on this paper, stating that a rock protruded through limestone rendered it dolomitic.

Professor Galbraith dissented from field geologists characterizing dolomitic rocks by colour or crystallization only, as analysis leads us to believe that these characters often lead us astray.

Professor Jukes observed, that the term which should properly be used in speaking of these rocks was not dolomite, but magnesian limestone, as he could instance cases in the experience of Mr. Wyley, in which the presence of magnesia in as small a per-centage as 5 per cent. had been detected by mere inspection alone.

Professor Harkness considered we must believe that dolomitization did not arise from igneous agency, but from forces acting externally to the rock, probably from the action of sea-water at great depth, under great pressure, by means of the decomposition of the sulphate of magnesia held in solution.

The Chairman stated the last opinion had often appeared to him to explain dolomitization as it occurred in this country, but not to explain the great masses of dolomite as they occur abroad.

Professor Galbraith objected to the theory, as we ought to find sulphate of lime along with the dolomite, if it were true.

Professor Harkness thought the sulphate of lime, being more soluble, ought to be carried away in solution.

Professor Galbraith dissented from this solution.

Mr. J. Beete Jukes also read the following paper:—

THE DRIFT OF WEST GALWAY AND THE EASTERN PARTS OF MAYO.

BY JOHN BIRMINGHAM.

Among the geological phenomena of Ireland not the least interesting are the escars, or gravel hills, which are found in all parts of the island. They differ from the drifts of other countries by presenting no fossili-

ferous testimony of their period; while the similar lines of gravel hills in Northern Europe are proved, by their resting on beds containing recent shells, to be of very modern origin. The Norfolk drift with Scandinavian pebbles, according to Lyell, also rests, at some points, on a fresh-water bed, with shells of existing species; and in the west of England boulder formation, as well as the drift of Wales and Scotland, are found shells of mollusca that now inhabit our seas. But the Irish escars, so far as hitherto known, neither contain fossils of their own, nor overlie any beds that discover their age. To account for the former circumstances, it would be only necessary to consider the character of their materials, when it would be plain that no shell could have resisted the grinding action of the moving gravel; but this would not so well explain why traces of the lithodomi, which I have always searched for in vain, should be wanting; and we must, therefore, seek a different cause for the absence of shells. I think this may be found in the probable fact that little, if any, of the drift that has been left behind by the waters, ever lay at the surface of the former sea bottom, the upper parts of which have been swept away beyond our ken; and the drift that we now see was derived from rocks that were situated at a depth to which no mollusca ever reached.

The escar drift is well developed in the west of Ireland; and in an extensive district which I have closely examined, in the west of Galway, and the eastern parts of Mayo, I think I have succeeded in discovering evidences of two other drifts. I will now venture to describe all three, giving them distinctive names for clearness sake, and classifying them in the order of succession upwards, as follows:—

1. The clay drift.
2. The great boulder drift.
3. The escar drift.

The movement of the first I believe to have been from a point between the south-east and the west; of the second, from a point between the north and the west; and of the third, from the south-west.

The "clay drift" forms prominent cliffs on the coast near Barna, about two and a half miles S. W. from Galway (Ordnance sheet 93); and similar ones occur at intervals round the eastern and southern shores of the bay to Ballyvaughan, in the county of Clare (O. S. 2). At Barna its great mass consists of limestone boulders and clay; but it is sparingly intermixed with granite, by which general name I will call the various syenitic rocks of Galway; and, at first view, one would see nothing remarkable in the mixture, as the cliffs are situated in a granite country. However, on a closer inspection it is easily perceived that the peculiar species of granites which are found in those cliffs are not the native rocks of the neighbourhood; nor have I found them *in situ* in any part of the igneous district of West Galway. The inference is, that they came from rocks that are still hidden beneath the waters of the bay; whence alone the drift could arrive without containing some of the granites that now form our dry land. But that it did not come from those parts of the bay which lie to the east or south-east, is shown by the drift of the Aughinish cliff (Clare O. S. 3), which is composed of

limestone boulders imbedded in a tenacious clay, without a trace of the sandstones of Slieve Aughta, which lies at no great distance in those directions. Neither is there any granite in this cliff, which corroborates the evidence of the Barna cliffs, that their materials did not come from any northerly source. It is proved, therefore, by the Barna cliffs, that this "clay drift" was not transported from any point of the compass in the north segment contained between the west and east. The Aughinish cliff proves this also, and to that segment adds from the east to the south-east; consequently, it must have been carried from some part of the smaller segment between the south-east and the west; a conclusion that is confirmed by the absence of granite in the drift of Aughinish; but I have found no data that might enable us to define its course more exactly.

The "great boulder drift" has left ample evidence of its progress. The Barna cliffs are strewed over with large granite and limestone blocks, and the granites, which are very different from those in the drift below, are easily recognisable as belonging to the rocks of the district to the north and north-west of Barna. The limestone boulders, which are less numerous, probably came from the district west of Lough Corrib; and some of them present the arenaceous appearance that I have remarked in the limestone about Oughterard near its junction with the granite. At Aughinish, though the drift there, as already stated, is unmixed with granite, still many boulders of that rock from the north-west are found on the surface of the land above. They are smaller and rounder than those on the Barna cliffs; and they may be traced over the country towards Slieve Aughta.

I think the distinction, direction, and sequence of these drifts are all sufficiently proved by the above examples. The distinction and sequence, and, less clearly, the direction, are shown where the boulder drift overlies detached masses of the clay drift in the granite country between Barna and Lough Corrib; as at Tonabrocky Hill, two and a half miles north of the Barna cliffs (O. S. 81); and at Glenlough, three-fourths of a mile N. E. of Tonabrocky (O. S. 82), where the clay drift shows signs of denudation before the deposition of the granitic gravel. The direction alone is proved by phenomena observable throughout the whole district referred to by this paper, and of which I will give a few examples.

At St. Brandon's Island, three miles S. E. from Galway (O. S. 94), we find large igneous boulders, the parent rocks of which lie to the north-west in the vicinity of the town.

About five miles S.W. of Oughterard (Galway O.S. 67), on the road from the village of Doon to Letter, and at less than a mile from the former, is a drift hill containing a large block of sandstone, but chiefly composed of the debris of hornblendic rocks. Leaving the road a short distance farther on, and ascending the hill to the right, the hornblendic rock is discovered *in situ*, covered with great boulders of syenitic porphyry, a characteristic rock with large crystals of flesh-coloured felspar and green hornblende; and this also may be found *in situ* at Knockalee Hill, at a distance of near two miles in a direction rather north of west.

The intervening hill is also covered with similar boulders, but larger, some of them far exceeding one hundred tons, and more angular; and it is worthy of remark that they seem inclined to cluster round the summits of the hills, rather than spread over the valleys between them.

The country adjoining Slieve Dart to the south-east, near Dunmore (Galway, O.S. 5), is full of its sandstones and conglomerates; and I think it unnecessary to cite any more of the various examples I have remarked of this drift, which I have characterized by the name of "boulder drift;" as its distinctive remains consist of the larger blocks that resisted the subsequent force which removed its lighter materials.

The escar drift in the greater part of my district is composed of limestone gravel of various degrees of fineness, mixed in a small proportion with the debris of other rocks. In its formation it is often amorphous, and often shows stratification more or less perfect, in which the coarser gravel and boulders generally incline towards the upper parts,—a fact that I think deserves especial notice, as it appears at variance with recognised geological theory. It might, perhaps, be referred to the action of light currents on the mass of previously deposited drift, the fine sand being carried away to a certain depth, and the larger stones and gravel left behind by a kind of winnowing process, and settling in an accumulation on the surface of the parts undisturbed.

The disposition of this drift would show a force moving towards the north-east, in the southern part of my district, and then assuming a northerly course, which it continued to the coasts of Mayo and Sligo. The lines of gravel hills are favourable in their direction to this hypothesis, which is also supported by their mineralogical evidence. The escars immediately to the south of the sandstone district of Slieve Dart contain little or no gravel of that formation, though its large boulders are scattered over other parts of the land. The southern slopes of Slieve Dart are swept pretty clear of small drift, which, on the northern side, covers, to a great depth, a large extent of country. A felstone dyke occurs at the north-eastern extremity of the sandstone, and its boulders are only found to the north. Its date may be posterior to the "boulder drift," and it may have been contemporaneous with the rise of the land during the escar period.

In the yellow sandstone, Silurian, and porphyry districts about Uggool and Kilkelly (Mayo O. SS. 72, 73, 81, 82), the ranges of escar hills, approaching from the south, contain but few specimens of rocks *in situ* to the north of them; and those were, probably, carried back from southern localities, whither they had previously been carried as "boulder drift." This remark is illustrated by a fine escar formation at Kilkelly, and about a mile east of that town an escar range commences within the sandstone country, and runs for about two miles, rather west of north, to the borders of the porphyry district. It is composed of mixed limestone and sandstone gravel, without containing, as far as I could see, any traces of the porphyry. Within the porphyry district the sandstone drift abounds, and its great boulders are seen close to the summit of the highest hill, at an elevation of near 700 feet above the level of the

sea. The whole sandstone country is full of hills of its own detritus, generally in confusion, but sometimes showing a tendency to lines running east and west, or S. W. and N. E., and with forms elongated in those directions. At Cahir (O. S. 81) limestone drift is found below sandstone at a depth of 20 feet, and may be an example of the "clay drift" underlying the "boulder drift." I have not examined the country farther north; but Mr. Griffith has proved a drift movement there, from south to north, as far as the sea. I may here remark, that eastward from Galway Bay, which would appear to have been the focus of a certain amount of divergence, the gravel hills seem to run in a more easterly direction.

The greatest apparent difficulty connected with the separation of the drifts lies in distinguishing between the "clay drift" and the escar formations; for they might be easily considered as identical and overlaid by the "boulder drift." The following are the reasons that induced me to make the division :—In the first place the "clay drift" of Galway Bay bears only on its surface, and never within it, any materials which can be referred to the "boulder drift;" and the escars, on the contrary, contain, mixed with the limestone gravel, that forms their chief bulk, many mica slates, greenstones, and other rocks, which must have been previously deposited by it, as no formations from which they could be derived lay in the course of the escar drift. In the next place, I think that the separation is justified by the appearance of the escar hill-chains, whose long unbroken lines suggest the idea that the force which shaped them was the last that passed over the surface of the present land; and as the "boulder drift" was subsequent to the "clay drift," so the escar drift was posterior to the former, which intervened between both the others.

Though I believe that we have thus sufficient data to prove the existence of three great drift periods in this district, still there are many deposits which it would be impossible to refer distinctly to any one of them. Beneath the alluvial flats, where our rivers run slowly in a deep channel, we often find a stratum of rounded boulder-stones imbedded in blue or yellow clay, and differing in that respect from the materials of the escars, which never advance beyond the borders of those plains. The rounding of the boulders is certainly not to be attributed to the action of the river itself at any period; for we have no reason to believe that the waters ever moved with greater velocity in those parts than at present, but rather less; for above the boulders there is generally a stratum of marl, and on this, the surface layer of alluvial soil, both containing shells of the most delicate structure, in so perfect a state of preservation as to convince us that they must have been deposited in almost still water. These shells are all recent, including the genera Planorbis, Lymnæa, Succinea, Paludina, Cyclas, &c., mixed with land shells; and their inhabitants must have lived at a time when the river was rather a succession of lakes, joined by narrow straits, before its waters cut a deeper way through the barriers that opposed their course, and, with a diminished breadth and reduced level, formed a channel through the lowest part of

their own previous deposits. But this formation exists in situations far removed from any rivers, and it often forms the subsoil of our higher lands. In the limestone country its boulders and gravel are chiefly limestone; but it contains in a greater proportion than the escars a mixture of Silurian and other sandstones, mica slates, greenstones, and sometimes granite; and indeed it is, probably, from the decomposition of those rocks that the blue and yellow clays which it contains are derived. The greater part of these beds and accumulations may have been originally deposited as boulder drift, and afterwards disturbed and mixed with new matter at the escar period. To the escar movement may be attributed the deeper soils and superior fertility of our greater hills on the north than on the south side.

Having explained my opinions, and the reasons on which they are founded, regarding the proper separation of our drifts into three great divisions, the places they occupy in relative position, and the directions in which they moved, I will now state my views as to what the force may have been by which those remarkable effects were produced. Two theories have been proposed,—one of which would make water the moving agent, and the other ice. The latter is the latest, and has the recommendation of novelty in its favour, besides the more substantial one of being the adopted of Agassiz.

It may be with the geologist as with the painter or the musician, in whose works, though they speak the universal language of genius, a national accent can still be noticed; and the ice or water theories may, to a great extent, owe their origin to the physical circumstances of the native countries of their proposers. An inhabitant of Switzerland who has been accustomed to observe the vast power of the glaciers grinding away the sides of mountains, scooping out their bed in the granite rock, and carrying the fragments of fallen peaks on the crests of their solid waves, must see that ice is indeed a great agent in geological phenomena; and, on the other hand, to a native of our western isles who has been viewing the Atlantic from his childhood, and has seen cliffs pulled down, and the huge masses of their debris tossed about by the surge, the force of water will be considered unsurpassed. One, as correctly as the other, might found a theory of limited applicability on the great power that he had been used to contemplate; but they would be equally wrong in seeking to give it too great a generalization.

I believe that Agassiz, though not the inventor of the glacial hypothesis, was the first who conjectured the former existence of glaciers in the British Islands, and it would be far from me to question the correctness of that great man's opinion, supported as it has been by our own most eminent geologists; but in the district to which this paper refers I believe that it is neither to land glaciers nor floating ice, but simply to the moving force of water, that we must attribute the phenomena of drift.

Nothing can be more marked than the increase in number, as well as in size and angularity, of our boulders as they are followed to their source; and my knowledge of that fact has often assisted me in tracing

them to their parent rocks, which are all to be found within a moderate extent of country. Their *decrease in number*, according to the remoteness from their native localities, might, indeed, be accounted for on glacial principles; but not so easily their *diminished size:* for though the ice-raft may waste away by degrees, and its powers of buoyancy become less, still this must be thought to effect the *total quantity*, rather than the *individual parts* of the load that it bears. As its cliffs succumb in its progress through the warm sea-waves, its burden may gradually be reduced; but there is no reason why the largest masses should not still be found among the mixed materials that are carried on its contracting area. If, to meet this objection, the inveterate glacialist would have recourse to the manipulation of various icebergs for the shaping of each diminished boulder, asserting that its reduced form was due to the lines of bedding, or divisional joints of the original mass, which rendered it liable to split into fragments when alternately let fall and taken up by successively advancing icebergs,—he may be told, that however applicable his explanation might be to the erratics of other regions, the short-travelled boulders of our district will be more simply, and therefore more probably, accounted for, by conceding, in this instance at least, the motive power to the ordinary waves and currents of the sea.

If ice were the transporting cause of our drift, we should expect to see scattered over the surface of the land even a few large blocks that escaped those conjectured vicissitudes of the smaller in their journey from distant localities; but they are never found so situated. The great boulders must be looked for near their source, and we have nothing like erratics of 100 tons, whose route must have been 100 miles or upwards.

I have already alluded to the unbroken lines of escar hills as a proof of their subsequency to the other drifts, and it is hard to imagine how they could escape the levelling action of icebergs, had these been floating about and impinging against the shores at the time of the final rise of the land. Of course, this remark applies also to Scandinavia and to other countries; and generally I would say, that the existence of escar chains seems to suggest the prevalence of a climate unfavourable to icebergs at the period of emergence from the waters; and this was precisely the time when I believe that the escars were formed.

Though the striation of rock-surfaces which I have observed in some parts of my district may be thought indicative of glacial action, still it does not follow that we must refer to that cause the various phenomena of the drifts. The comparatively local character of those deposits which I have alluded to above is unfavourable to such an idea; and the stratification that the drift so often shows is a proof that, however it had been originally accumulated, it comes finally under the action of the waves and currents, so that its present condition, or that with which we have to deal, must in any case be attributed to aqueous causes. At the same time, I do not think that the parallel striation of surface rocks can always be so confidently ascribed to the operation of icebergs. On account of the probable unevenness of the sea bottom, it is likely that when an

iceberg began to touch the ground, it would strike it on a surface of very small extent at a time. The greater portion of the berg would be afloat; and as this, of course, would yield to the action of the waves more than the part aground, the result would be a curvilinear motion of great irregularity, and subject to constant alteration as the iceberg advanced and struck ground in other parts; and even if a portion of it were absolutely afloat, the prominences of the bottom would form temporary centres of revolution as it was thrust forward. From this I should expect very great confusion in the tracks of icebergs over an extended area, and but little similarity between them and the markings of a glacier on dry land, where the even motion is derived from quite different causes. The scorings that I have observed in my district correspond with the lines of escar hills, and show for many miles an unchanged direction from S.W. to N.E. The polished ends of the rocks face the south-west, and show that the movement, like the escar drift, proceeded from a quarter unfavourable to arctic conditions. Might not the surface striæ be referred to the rubbing of large flat masses of boulder rocks, which were pushed forward by the waves before they became sufficiently rounded to roll? It would be no wonder that the lines, thus engraved, should everywhere betray the direction of the single force that caused them, or, in other words, be parallel to each other.

If my reasons for rejecting the floating-ice theory, as applicable to the drifts of my district, be considered of any weight, I may object, with great confidence, to the land-ice hypothesis. The escar chains bear little resemblance to moraines, the character of which I have observed closely in the Alps, and the drift that has ascended to higher levels was certainly not borne on sliding glaciers.

Still I must not be considered as disputing the possibility, or even probability, of the prevalence of a glacial climate here at some comparatively modern period of the earth's history. It is easy to conceive that a time may have been when the disposition of land and water in the northern hemisphere was similar to what it is at present in the southern, and that loaded icebergs may have come down from a great arctic continent to latitudes even south of Great Britain and Ireland. But whatever opinion we may form on this point, my impression is that the drift deposits under consideration do not show any structure or phenomena which cannot be more easily ascribed to the simple action of water than to the agency of those frozen rafts. We may leave the far-travelled erratics of other countries to satisfy the demands of the glacialist; but I must claim the formation of at least our Galway and Mayo drifts for the liquid force of the ocean; and I will now try to explain how I think they could be derived from the force of currents and breakers without the intervention of ice.

I will begin with the "boulder drift," which I believe was deposited during a sinking of the land. I am aware that Mr. Darwin has written on the ascent of hills by boulders; but I have not seen his paper, and cannot tell how far his views may agree with or differ from the following:—

As the subsidence took place, the breakers pushed before them the masses that they had riven from the cliffs, breaking many into fragments, and rounding them as they progressed with the advancing boundary of the sea. In this manner was effected the transit of boulders, continually decreasing in size over the face of the submerging country; and thus, also, were the blocks driven up the hills while these went down progressively below the water line. But while the breaker action on the surface directly exposed to it would tend to drive the drift towards the dry land, or upwards, the currents would produce a contrary effect, and, running deeply, and with great force, among the submerged hills, they would carry the smaller drift down their sides, and bear it along to a distance. On the sides of the hills not fronting the force of the waves, these would also drive the drift downwards, but only to the extent limited by the trifling depth that can be reached by breaker-action; and by this separation of the effects of breakers and currents, the course of the latter during a period of submergence might be inferred from the drift that has come from distant and higher levels, if not subsequently disturbed, and the direction of the prevailing winds may be conjectured from the great boulders about the summits of hills. Accordingly, we have grounds for concluding that at the time of the "boulder-drift" currents the predominant winds were not far from due west. The tendency of the large blocks to gather round the summits of the hills shows that the latter existed at that period, and it may be, that few considerable changes in the relative levels of the district have occurred since. During the re-emerging of the land, the forward motion of boulders under breaker action would be continuously down hill on the sides not opposite to the force, but on the side opposed to it the great boulders of a former period would be little changed in position. They could not now be rolled any further up hill, as the sea was retreating; nor would they be carried down the slope, which would be a motion of advance against the force, and to the extent of the excess of length that the ordinates towards the base of the hill would have over those towards its summit in a curve of its vertical profile. Thus the great boulders of the submerging period have, in certain situations, been left as its memorials; in other places the drift of that time was subsequently swept away, and portions of it now represent the escar drift, in which we find materials, as before stated, mixed with the prevailing limestone gravel, that lie at various points between S. E. and N. E. from their sources, according to the distance that they were carried away from their first resting-place where they had been deposited as boulder drift. In consequence of this displacement it is difficult to define the course of that drift within many degrees of its true direction, but we can scarcely err in saying that it came from some point between the north and west. At the same time it is possible—though the probabilities do not seem favourable to the supposition—that the portions of the "boulder drift," which have come from higher levels may have been first removed during the emergence of the land early in the period of the escar drift, and that subsequently a change in the direction of the cur-

rents took place. In this case the boulder history of the previous submergence would refer only to the direction of the prevailing winds, and not to that of the currents.

The granite boulders on the Barna and Aughinish cliffs, already noticed, are, probably, the representatives of a thick formation of overlying "boulder drift;" and they may have reached their present position, returning to the vicinity of their parent rocks, and at the same time sinking through the diminishing mass of smaller materials borne away by the escar currents.

It would be idle to enter into any minute details of the various phenomena of the drifts. My object is, to explain the conclusions which the study of their principal features has suggested. These are sufficient to distinguish them from each other, and, as I believe, to show that the supposed agency of ice, as opposed to water, cannot simplify their formation in our eyes, but, on the contrary, must render it more difficult to be understood. It is to be remembered that, if parts of the drift show a confused arrangement of their materials, others are stratified; and, instead of arguing from the former that it must have been deposited from ice, it should rather be concluded from the latter, that stratification is not always the result of the action of water; and that conditions may exist which would prevent water from giving the orthodox regularity of bedding, which preconceived notions would lead us to expect. Indeed, I have remarked, as a general rule, that where fine sand occurs, stratification is sure to be found; and its absence is chiefly noticed in coarse gravel and tenacious clay, which often form the great bulk of the drifts.

Now, as a *summing up*, I may briefly state my belief that the clay drift was deposited during an emergence of the land; the boulder drift during a subsequent submergence; and the escar drift at its re-emergence.

I think that the general contour of the country in the north of Galway and adjoining parts of Mayo shows the occurrence of great denuding action from the east at a period anterior to the drifts. The shapes of the hills are, in most cases, elongated in an easterly and westerly direction; steep on the north and south sides, and eastern end, and stretching away to the west in a long declining ridge. The rock often appears, or nearly approaches the surface, at the eastern acclivity; and throughout all the district I have remarked that, generally, the rise of outcropping strata is towards the low lands, proving them to be valleys of denudation where the upheaval and disturbance of the beds rendered them liable to be carried away. A grand illustration of this phenomenon may be seen on the Burren Mountains, south of Galway Bay. Long lines of platforms ascend their sides like stairs of giants; and in these the geologist will not fail to recognise the beach-terraces of an ancient sea, made during pauses in the building process of man's abode. Those terraces have a dip that corresponds with that of the strata; and this may be observed on the eastern and western sides of the hills. Its direction is southerly, towards the mountain group, so that the elevation is towards the valley of the bay, and the low country to the east.

I have thus attempted to describe the drift of rather an extensive district; and to explain the ideas which its appearances have suggested. In rejecting the glacial hypothesis in its particular case, I know I shall have few supporters; for the adoption of the ice-theory has been so general that it is esteemed nothing less than a geological sin to *think* of any other; and even I myself was so impressed with the popular respect for it that I began my examinations with strong prejudices in its favour. By degrees, however, I became convinced that every force connected with drift need not, by any means, like *Kabibonoka*,

"Have its home among the icebergs;"

and, while difficulties exist in the way of attributing everywhere to glacial agency the formation of superficial deposits, the objections to an aqueous theory chiefly arise from misconception of the action of water, and ignorance of its real motive power in currents and breakers.

If I fail to convince others of the correctness of my views, my remarks may at least have the effect of drawing more attention to an interesting division of our geology than has hitherto been bestowed on it; and, in the final approval or rejection of my opinions, I hope equally to attain my object, which is the discovery of truth.

I must consider it unfortunate that the eminent compiler of our Geological Map, Mr. Griffith, has not studied the drift formations with the same assiduity that, in the case of the solid strata, has made him distinguished by important discoveries. At the same time, he has not been wholly inattentive to the former; for, in certain parts of Ireland, he has noticed a drift from the north-west, corresponding, probably, with what I have called "the boulder drift" in my district; and to the north of that country he has proved the existence of a southern drift, whose great boulders, rolled down the northern slopes of the Ox Mountains, as well as the gravel hills running south and north at Killala, seem to complete the evidences of the escar movement to the sea.

I cannot conclude without expressing my regret at the general want of appreciation of Geological Science in the country, and the apathy manifested with respect to a subject which equally concerns the philosopher and the practical man, and ought to be so valued by him who loves to worship God in the contemplation of his works. If the study of worlds through space can exalt our ideas of Omnipotence, not less edifying are the revelations of divine wisdom in the structure of the globe we inhabit; and, when the astronomer would address Heaven with his face towards the stars, the geologist may pray looking downwards; nor need piety seek sublime aspirations beyond the ruin-built temple of the earth. But we may hope that the advancing taste for knowledge may lead to a more just estimation of Geology, whose history, read from wasted monuments, presents, indeed, many an unlettered space: yet those dim intervals only add to its sublime interest, heightening the charms that invest it, like the shadows of summer clouds chequering the mountain landscape with beautiful darkness.

Professor Jukes instanced cases in England in which large blocks of rock had been carried from south to north, probably by secondary currents to the north.

Mr. J. BEETE JUKES read a paper by M. ALPHONSE GAGES, Curator of the Museum of Irish Industry—

ON PSEUDOMORPHIC TREMOLITE INCRUSTED WITH CARBONATE OF LIME AND MAGNESIA, BEING APPARENTLY THE MINERAL DESCRIBED BY DUFRENOY, UNDER THE NAME OF MIASCITE.

IN the supplementary part of his "Traité de Minéralogie," vol. iii., p. 770, Ed. 1845, M. Dufrénoy has described, under the name of Miascite (Miaskite), two very distinct substances.

The first is a grayish felspathic rock, composed chiefly of felspar uniaxal mica and elæolite. It was first described by G. Rose in the account of the journey of Humboldt, Ehrenberg, and G. Rose, to the Ural Mountains.

The name of Miaskite was given to this rock from its occurrence in the hills in the neighbourhood of Miask, in Siberia.

The second substance described under the name of Miaskite was also derived from the same locality just named, whence it was sent to M. Adam. M. Dufrénoy examined it, and considered it to be dolomite.

In examining the collection of minerals in the Museum of Irish Industry, I found a specimen labelled "Miaskite," and answering perfectly to the description given by Dufrénoy of the substance examined by him.

The remarkable structure of this mineral, formed as it were, of a series of crystalline fibres arranged parallel to one another, may be compared to a bundle of flax or of thread, completely incrusted with saline matter, the crystals of which have disposed themselves in the direction of the fibres. This peculiar structure gives it the aspect, at first sight, of fossil-wood, but a close examination led me to suspect that it was the result of pseudomorphic action. Having removed a fragment of the external part of the specimen by splitting it in the direction of the fibres, I introduced it into very weak hydrochloric acid; the result obtained after some days of contact with the acid confirmed my supposition: the acid dissolved a quantity of lime and magnesia, and left an asbestos-like skeleton.

Having submitted another portion to analysis, the following numbers were obtained as the result:—

Carbonate of lime, ...	57·483
Do. magnesia, ...	40·510
Sesquioxide of iron and alumina, . .	0·375
Asbestiform skeleton, ...	1·595
Water and organic matter, ...	0·239
	100·202

If we deduct the iron, water, skeleton, &c., and calculate the relative proportions of carbonate of lime, and of carbonate of magnesia in 100 parts of the mixed carbonates, we obtain the following results:—

Carbonate of lime, ...	58·660
Do. magnesia, ...	41·339
	99·999

True dolomite, or $CaO, CO_2 + MgO, CO_2$ would give the following composition in 100 parts:—

Carbonate of lime, ...	54·201
Do. magnesia, ...	45·798
	99·999

The mineral analyzed may, therefore, be considered as a mixture of dolomite and calcite in the following proportions:—

$CaO, CO_2 + MgO, CO_2$, ...	90·262
CaO, CO_2, ...	9·738
	100·000

The insoluble skeleton, when dried, had the appearance of an asbestiform Tremolite, and its analysis gave the following result:—

Silica, ...	68·181
Magnesia, ...	28·909
Alumina and traces of iron, . . .	2·181
	99·271

It is probable, therefore, that this skeleton was Tremolite, from which water impregnated with carbonic acid had removed the whole of the lime. Thus, if we deduct the per centage of lime, and calculate the remaining numbers in 100 parts in the analysis of the specimen of Tremolite from Wermland, made by Bonsdorff, and compare the results with the preceding analysis of the skeleton, we shall get the following numbers:—

	Tremolite from Wermland, analyzed by Bonsdorff.	Tremolite, supposing the whole of the lime removed.	Asbestiform skeleton, analysed by me.
Silica, ...	59·75	69·565	68·181
Lime, ...	14·11		
Magnesia, ...	25·00	29·107	28·909
Protoxide of iron, .	0·50	0·582	
Fluorine, ...	0·94	1·094	
Water, ...	0·10	0·116	
	100·40	100·464	

The water which exists in the mineral evidently belongs to the skeleton; but as its quantity could not be absolutely determined, owing to the presence of organic matter, I have not attempted to calculate a formula for the asbestiform skeleton.

Another explanation of the origin of the skeleton suggests itself, namely, that the mineral was not hornblendic, but augitic; for example, like the asbestiform Diopside from Zillerthal, examined by Meitzendorf, when augitic minerals are acted upon by water containing carbonic acid in solution, the lime is removed, and nearly the whole of the magnesia is left behind, of which the Rensselaerite of Beck is an example.

Numerous other examples of this kind have been given by Beudant, Svanberg, &c.

The organic matter noted in the analysis appeared to have been derived from infiltrated waters, and followed the direction of the fibres. When a fragment of the mineral was heated in a small glass tube, the junction of the fibres was well marked by black lines from the charred matter. Whatever may have been the original mineral, it must have been considerably modified before the incrustation began. The proportion which the skeleton bears to the whole mass of the mineral in its present form is so small, that some of the original fibrous mineral must have been wholly removed before the remainder began to be incrusted.

The peculiar character of the pseudomorph, especially if we assume that it was Tremolite, which is so frequently found in calcareous rocks, suggests the idea that many of the fibrous varieties of dolomite may have been formed in a similar way. It would be worth while to examine some specimens of these dolomites from this point of view.

The Meeting then adjourned to the second Wednesday in February.

ANNUAL GENERAL MEETING, FEBRUARY 10, 1858.

GILBERT SANDERS, M.R.I.A., in the Chair.

THE Society met at 2 o'clock, when the following Report from Council was submitted and adopted:—

REPORT.

YOUR Council have much pleasure in congratulating the Society on the amount and quality of the work done during the past year, and on the position of the Society at the present time.

The addition to the number of Members consists of four Life Members, and sixteen Annual Subscribers, making a total of twenty; from which, however, eleven must be deducted, as lost from death and other causes, leaving a balance of nine Members gained during the past year.

Among the Undergraduate Associates, indeed, who last year numbered twenty-one, there is a loss of seventeen, either from their having become Graduates, or from other causes, while only one new Associate Member has joined the Society. As this class of Members is necessarily

a temporary and fluctuating one, it has been thought better that, for the future, their election should be for the session only, and that their numbers should not be included in those of the permanent Members of the Society.

The Members of the Society now, as compared with the corresponding numbers at the close of last year, will stand as follows:—

	1857.	1858.
Honorary Members, ...	4	4
Honorary Corresponding Members . .	3	3
Life Members, ...	52*	58
Annual Subscribers, ...	87*	90
	146	155

Omitting the Associates, the Society seems to be regularly enlarging the numbers of its Members at the rate of about ten per annum.

Among the Members lost to the Society, the one most deeply to be regretted is Robert Ball, LL. D., formerly Secretary and President of the Society; whose sudden and lamented death deprived us, in common with the whole scientific public of Dublin, of one equally characterized by intellectual ability, high personal character, and kindly disposition, and who had for many years rendered services of the highest value to the Society.

Among our other losses are some who, having paid their arrears of subscription, have, to our regret, withdrawn from the Society, and others whose names have been removed from our books in consequence of those arrears not having been paid. Your Council will not seek to conceal from you that there are still retained on the books the names of several persons which must, in like manner, shortly be removed if those arrears are not paid up.

They have no doubt that these arrears of unpaid subscriptions are the result of oversight in the first instance; and would observe, that it would greatly conduce to the welfare of the Society if the subscriptions were always regularly paid soon after they became due.

Your Council have much satisfaction in calling your attention to the soundness of the financial condition of the Society, owing to the strenuous efforts that have been made to reduce the expenses; remarking, however, at the same time, that increased funds would enable them to increase the value and utility of the Society both to the Members and to the public.

Your Council would congratulate the Society on the change of their place of meeting, and call your attention to the far greater comfort and convenience with which the Evening Meetings are now held than formerly. They desire to record, on their own behalf and that of the Society at large, their sense of obligation to the Board of Trinity Col-

* One of the first and two of the second of these classes were omitted by mistake last year, viz., John King, Esq.; the Archbishop of Dublin, and E. Percival Wright, M.B.

lege, for the permission to hold their Evening Meetings in the new buildings, not forgetting the debt of gratitude due to their old and valued Vice-President, Dr. Lloyd, for having so long afforded us the use of his rooms for all the purposes of the Society, and for still continuing to do so for the Meetings of the Council, and the place of deposit of the Library.

A slight change has been made in the By-Laws of the Society during the past year, the effect of which is,—

1st. To allow Annual Subscribers to pay either an entrance fee of £1 and an annual subscription of £1, or an entrance fee of £5 and an annual subscription of 10*s.*; and—

2ndly. To enlarge the term from one month to sixty-three days, during which a non-resident Life Member may reside within twenty miles of Dublin, without being liable for his annual subscription; and to reduce such annual subscription, when due, from £1 to 10*s.* It is also proposed that any Annual Subscriber who has paid an entrance fee of £5 may at any time compound by a further payment of £5 for his annual subscription of 10*s.*

In the Appendix will be found:—1st, the names and addresses of the Members now on the books of the Society; 2ndly, the list of the Societies and bodies entitled to receive a copy of the "Journal of the Geological Society of Dublin;" 3rdly, the names of those lost and gained during the past year; 4thly, the donations received during the past year; and 5thly, an abstract of the account of the Treasurer, regularly audited, in which there appears a balance of £71 14*s.* 8*d.* to the credit of the Society.

APPENDIX TO ANNUAL REPORT.

No. I.

LIST OF MEMBERS, CORRECTED TO JANUARY 31, 1858.

Members are requested to correct errors in this List, by letter to the REV. SAMUEL HAUGHTON, *Trinity College, Dublin.*

HONORARY MEMBERS.

Elected.
1844. 1. Boué, Amie, F. G. S., *Paris.*
1844. 2. Lyell, Sir Charles, F. R. S., 11, *Harley-street, London.*
1844. 3. Murchison, Sir Roderick J., G. C. St. G., F. R. S., H. M. R. I. A., 16, *Belgrave-square, London.*
1832. 4. Sedgwick, Rev. A., M. A., F. R. S., *Cambridge.*

HONORARY CORRESPONDING MEMBERS.

1854. 1. Thomas Oldham, F. R. S., *India.*
1854. 2. Arthur A. Jacob, C. E., *India.*
1855. 3. Joseph Medlicott, *India.*

MEMBERS WHO HAVE PAID LIFE COMPOSITION.

1853. 1. Allen, Richard Purdy, 22, *Blackhall-place.*
1857. 2. Carson, Rev. Joseph, D. D., *Trinity College.*
1832. 3. Davis, Charles, M. D., M. R. I. A., 33, *York-street.*
1857. 4. Green, John Ball, 6, *Ely-place.*
1857. 5. Haliday, A. H., A. M., F. L. S., M. R. I. A., *Harcourt-street.*
1831. 6. Hamilton, Sir W. R., M. R. I. A., *Observatory, Dunsink.*
1848. 7. Haughton, Rev. Professor, F. G. S., 40, *Trinity College.*
1850. 8. Hone, Nathaniel, M. R. I. A., *St. Doulough's, Co. Dublin.*
1831. 9. Hutton, Robert, M. R. I. A., F. G. S., *Putney Park, London.*
1851. 10. Jukes, Joseph Beete, A. M., F. R. S., M. R. I. A., 51, *Stephen's-green.*
1834. 11. King, Hon. James, M. R. I. A., *Mitchelstown.*
1844. 12. King, John, *Dame-street.*
1848. 13. Luby, Rev. Thomas, D. D., M. R. I. A., *Trinity College.*
1851. 14. Malahide, Lord Talbot de, F. R. S., *Malahide Court, Malahide.*
1838. 15. Mallet, Robert, C. E., M. R. I. A., F. G. S., *Delville, Glasnevin,* and 11, *Bridge-street, Westminster, London, S. W.*
1846. 16. Murray, B. B., 69, *Lower Gardiner-street.*
1835. 17. Saunderson, Alexander, *Castle Saunderson, Co. Cavan.*
1851. 18. Whitty, John Irvine, LL. D., 20, *Upper Fitzwilliam-street.*

MEMBERS WHO HAVE PAID HALF LIFE COMPOSITION.

1831. 1. Baillie, Rev. James Kennedy, D. D., M. R. I. A., *Ardtrea, Stewartstown.*
1854. 2. Barnes, Edward, *Ballymurtagh, Co. Wicklow.*
1832. 3. Bryce, James, *High School, Glasgow.*

Elected.		
1854.	4.	Clemes, John, *Luganure Mine, Glendalough, Co. Wicklow.*
1855.	5.	Carter, Sampson, C. E., *Kilkenny.*
1857.	6.	Crawford, Robert, *care of Messrs. Peto and Betts*, 9, *Great George's-street, Westminster.*
1856.	7.	Du Noyer, G. V., M. R. I. A., 51, *Stephen's-green.*
1832.	8.	Dunraven, Lord, 20, *Merrion-square, North.*
1836.	9.	Enniskillen, Earl of, M. R. I. A., *Florence Court, Enniskillen.*
1844.	10.	Esmonde, Sir Thomas, Bart., M. R. I. A., 9, *Great Denmark-street.*
1854.	11.	Foote, Frederick J., 51, *Stephen's-green.*
1853.	12.	Harkness, Professor, F. G. S., *Queen's College, Cork.*
1856.	13.	Haughton, Lieut. John, R. A., *St. Helena.*
1857.	14.	Haughton, John Hancock, Esq., *Carlow.*
1840.	15.	Jackson, James E., *Tulliderry, Blackwatertown.*
1839.	16.	James, Colonel, R. E., F. R. S., M. R. I. A., *Ordnance Survey Office, Southampton.*
1832.	17.	Kearney, Thomas, *Pallas-green, Co. Limerick.*
1857.	18.	Keane, Marcus, *Beech Park, Ennis, Co. Clare.*
1835.	19.	Kelly, John, *Mountpleasant-square.*
1853.	20.	Kinahan, George H., *Seaview-terrace, Donnybrook.*
1839.	21.	Lansdowne, Marquis of, 54, *Berkeley-square, London.*
1838.	22.	Larcom, Lieut.-Col., R. E., LL. D., F. R. S., M. R. I. A., *Phœnix Park.*
1840.	23.	Lindsay, Henry L., C. E.
1832.	24.	Mac Adam, James, F. G. S., 18, *College-street, East, Belfast.*
1840.	25.	Montgomery, James E., M. R. I. A.
1856.	26.	Molony, C. P., Capt., 25th Regt., Madras N. I., *per Messrs. Grindlay and Co.*, 63, *Corn-hill, London.*
1856.	27.	Medlicott, Henry, *Roarkee, Bombay.*
1857.	28.	M'Ivor, Rev. James, *Rectory, Moyle, Newtownstewart, Co. Tyrone.*
1845.	29.	Neville, John, C. E., M. R. I. A., *Dundalk.*
1852.	30.	O'Kelly, Joseph, 51, *Stephen's-green.*
1844.	31.	Palmerston, Viscount, G. C. B., M. P., 4, *Carlton Gardens, London.*
1832.	32.	Portlock, Major-Gen., R. E., F. R. S., M. R. I. A., 58, *Queen's Gardens, Hyde Park.*
1832.	33.	Renny, Henry L., R. E., M. R. I. A., *Finglas.*
1854.	34.	Smyth, W. W., *Jermyn-street, London.*
1832.	35.	Tighe, Right Hon. William, *Woodstock, Innistiogue.*
1834.	36.	Verschoyle, Archdeacon, *Rathbarron, Collooney.*
1853.	37.	Webster, William B., 104, *Grafton-street.*
1846.	38.	Willson, Walter, 51, *Stephen's-green.*
1854.	39.	Wyley, Andrew, 51, *Stephen's-green.*
1857.	40.	Wynne, Arthur B., 51, *Stephen's-green.*

ANNUAL MEMBERS.

1831.	1.	Apjohn, James, M. D., F. R. S., M. R. I. A., 32, *Lower Baggot-street.*
1854.	2.	Ashton, Samuel, *Woodfield, Newtownbarry.*
1857.	3.	Baily, W. H., 51, *Stephen's-green.*
1844.	4.	Bective, Earl of, *Headford, Kells.*
1855.	5.	Barton, H. M., 5, *Foster-place.*
1855.	6.	Byrne, Griffin, *Lower Mount-street.*
1844.	7.	Byrne, Patrick, 27, *Talbot-street.*
1831.	8.	Brady, Right Hon. Maziere, M. R. I. A., 26, *Upper Pembroke-street.*
1857.	9.	Bandon, Right Hon. Lord, *Castle Bernard, Co. Cork.*
1857.	10.	Bolton, George, Jun., 2, *Lower Merrion-street.*
1840.	11.	Callwell, Robert, M. R. I. A., 25, *Herbert-place.*
1857.	12.	Carte, Alexander, M. B., *Royal Dublin Society.*
1834.	13.	Croker, Charles P., M. D., M. R. I. A., 7, *Merrion-square, West.*
1855.	14.	Clarke, Edward, M. D., *Richmond-hill, South.*

Elected.
1857. 15. Craig, G. A., C. E., 6, *Ely-place.*
1832. 16. Curran, W. H., 9, *Fitzwilliam-place.*
1846. 17. D'Arcy, Matthew, M. R. I. A., *Anchor Brewery, Usher-street.*
1855. 18. Domvile, Sir C. H., *Santry House.*
1849. 19. Downing, Samuel, C. E., LL. D., 6, *Trinity College.*
1832. 20. Dublin, The Archbishop of, *The Palace, Stephen's-green.*
1839. 21. Duncan, James, M. D., *Farnham House, Finglas.*
1857. 22. Dowse, Richard, *Blessington-street.*
1852. 23. Doyle, J. B., *Martello-terrace, Sandymount.*
1858. 24. De Vesci, Lord, *Abbeyleix House, Abbeyleix.*
1857. 25. Farran, Charles, M. D., *Feltrim, Malahide.*
1857. 26. Fitzwilliam, Earl of, *Mortimer House, Halkin-street, London.*
1856. 27. Flemming, Lionel J., C. E., 2, *Henrietta-street.*
1853. 28. Flanagan, Stephen W., *Fitzwilliam-place.*
1857. 29. Frith, R. J., C. E., *Terenure-terrace, Roundtown.*
1849. 30. Galbraith, Rev. Joseph A., F. T. C. D., M. R. I. A., *Trinity College.*
1856. 31. Ganley, Patrick, 78, *Capel-street.*
1849. 32. Gyles, A. M'Gwire, *Saunders' Court, Kyle, Enniscorthy.*
1853. 33. Geoghegan, Henry, Jun., 41, *Rathmines-road.*
1831. 34. Griffith, Sir Richard, LL. D., M. R. I. A., F. G. S., 2, *Fitzwilliam-place.*
1857. 35. Gordon, John, C. E., *Dominick-street.*
1852. 36. Gordon, Samuel, M. D., M. R. I. A., 11, *Hume-street.*
1856. 37. Good, John, *City-quay.*
1831. 38. Hamilton, Charles W., M. R. I. A., 40, *Lower Dominick-street.*
1850. 39. Head, Henry, M. D., M. R. I. A., 28, *Upper Mount-street.*
1857. 40. Hampton, Thomas, C. E., 6, *Ely-place.*
1832. 41. Harrison, Robert, M. D., M. R. I. A., 1, *Hume-street.*
1848. 42. Harvey, Professor, M. D., M. R. I. A., F. L. S., 40, *Trinity College.*
1834. 43. Hutton, Thomas, M. R. I. A., F. G. S., 116, *Summer-hill.*
1853. 44. Hemans, George W., C. E., M. R. I. A., 10, *Rutland-square, East.*
1852. 45. Jellett, Rev. Professor, F. T. C. D., M. R. I. A., 6, *Trinity College.*
1842. 46. Jennings, F. M., M. R. I. A., F. G. S., *Brown-street, Cork.*
1855. 47. Kavanagh, J. W., *Apsley House, Rathmines.*
1857. 48. Kincaid, Joseph, Jun., 8, *Herbert-street.*
1856. 49. Kinahan, John R., A. B., M. D., M. R. I. A., *Seaview-terrace, Donnybrook.*
1853. 50. Kingsmill, Henry, Jun., *Sidmonton, Bray.*
1853. 51. Kirwan, John Stratford, 15, *Merrion-square.*
1854. 52. Locke, John, 14, *Henrietta-street.*
1831. 53. Lloyd, Rev. Humphrey, D. D., M. R. I. A., 35, *Trinity College.*
1854. 54. Longfield, Rev. George, F. T. C. D., *Trinity College.*
1856. 55. Lentaigne, John, M. D., *Great Denmark-street.*
1855. 56. M'Causland, Dominick, 12, *Fitzgibbon-street.*
1831. 57. M'Donnell, John, M. D., M. R. I. A., 4, *Gardiner's-row.*
1852. 58. Mac Donnell, Rev. Richard, D. D., M. R. I. A., Provost of Trinity College, *Provost's House, Trinity College.*
1849. 59. Maguire, Thomas, 46, *Kildare-street.*
1837. 60. Mollan, John, M. D., M. R. I. A., 8, *Fitzwilliam-square, North.*
1851. 61. M'Dowell, George, F. T. C. D., 6, *Trinity College.*
1853. 62. M'Cartney, George, *Lowther Lodge, Balbriggan.*
1856. 63. M'Guire, Joseph, C. E., *Kenilworth-square, Rathgar.*
1831. 64. Nicholson, John, M. R. I. A., *Balrath House, Kells.*
1856. 65. O'Brien, Octavius, 23, *Kildare-street.*
1857. 66. O'Meara, Rev. Eugene, 57, *Great Brunswick-street.*
1832. 67. Patten, John, *Royal Dublin Society.*
1848. 68. Petherick, John, *Knockmahon, Kilmacthomas.*
1857. 69. Phayre, George, C. E., *Strand-road, Sandymount.*
1852. 70. Pigot, Right Hon. Chief Baron, M. R. I. A., 52, *Stephen's-green.*
1857. 71. Porter, William, C. E., 13, *Charlemont-mall.*

1857. 72. Reeves, R., 22, *Upper Mount-street.*
1856. 73. Robinson, Hartstong, 15, *St. James's-terrace, Malahide.*
1849. 74. Rowan, Archdeacon, A. M., M. R. I. A., *Belmont, Tralee.*
1852. 75. Smith, Robert, M. D., M. R. I. A., 63, *Eccles-street.*
1852. 76. Sanders, Gilbert, M. R. I. A., 2, *Foster-place.*
1854. 77. Scott, Robert H., *Salem-place.*
1844. 78. Shirley, Evelyn J., *Loughfew, Carrickmacross.*
1849. 79. Sidney, F. J., LL. D., M. R. I. A., 19, *Herbert-street.*
1856. 80. Salter, J. W., *Museum of Practical Geology, Jermyn-street, London.*
1857. 81. Stack, Rev. Thomas, *Trinity College.*
1857. 82. Tait, Alexander, C. E., *Santry.*
1832. 83. Wall, Rev. C. W., D. D., M. R. I. A., 20, *Trinity College.*
1857. 84. Welland, W. J., 48, *Upper Rutland-street.*
1855. 85. Willis, Hamilton, *Ballycorus Lead Works, Golden Ball.*
1849. 86. Willock, Rev. William A., F. T. C. D., *Cleenish Rectory, Enniskillen.*
1851. 87. Wright, Edward, LL. D., M. R. I. A., *Floraville, Donnybrook.*
1853. 88. Wright, E. Percival, M. B., M. R. I. A., *Museum, Trinity College.*
1839. 89. Wynne, Right Hon. John, *Hazlewood, Co. Sligo.*
1843. 90. Yeates, George, M. R. I. A., 2, *Grafton-street.*

ASSOCIATES.

1. Brownrigg, W. B., *Adelaide-road.* Proposed 1857–8.
2. Babington, W. D., *Roebuck, Dundrum.* Ditto.
3. Green, M. Saunders, 5, *D'Olier-street.* Ditto.

No. II.

SOCIETIES AND INSTITUTIONS ENTITLED TO RECEIVE THE JOURNAL OF THE GEOLOGICAL SOCIETY OF DUBLIN.

ABERDEEN, . University Library.
BELFAST, . . Queen's College Library.
BRISTOL, . . Institution for the Advancement of Science, Literature, and the Arts.
CAMBRIDGE, . Philosophical Society.
University Library.
CORK, . . . Queen's College Library.
Royal Institution.
DUBLIN, . . Royal Irish Academy.
University Library.
Royal Dublin Society.
Natural History Society.
Ordnance Survey Library.
Geological Survey of Ireland.
University Philosophical Society.
Geological Survey of Ireland.
University Philosophical Society.
University Zoological and Botanical Association.
EDINBURGH, . Royal Society.
Wernerian Society.
Society of Arts.
University Library.
GALWAY, . . Queen's College Library.
KILKENNY, . Archæological Society.
LEEDS, . . Geological and Polytechnic Society of the West Riding of Yorkshire.

LIVERPOOL, .	The Literary and Philosophical Society.
	Historic Society of Lancashire and Cheshire.
LONDON, . .	Geological Survey, *Jermyn-street.*
	British Museum.
	Society of Arts, *John-street, Adelphi.*
	Royal Institution, *Albemarle-street.*
	Royal Society, *Somerset House.*
	Geological Society, *Somerset-house.*
	Linnæan Society, *Soho-square.*
	Geographical Society, 15, *Whitehall-place.*
	Civil Engineers' Institute, 25, *Great George's-street, Westminster.*
	Royal Asiatic Society.
	Zoological Society.
	Athenæum.
	Literary Gazette.
	The Hon. the East India Company, *East India House.*
MANCHESTER,	Geological Society.
	Institute.
OXFORD, . .	Bodleian Library.
	Ashmolean Society.
PLYMOUTH, .	Plymouth Institution and Devon and Cornwall Natural History Society.
ST. ANDREW'S,	University Library.
FOREIGN, . .	The Editors of Silliman's Journal of Science and Art, *New York.*
	Natural History Society, *Philadelphia.*
	Natural History Society, *Boston.*
	Smithsonian Institute Library, per Henry Stevens, Esq., *Morley's Hotel, Trafalgar-square, London.*
	Canadian Institute, per Thomas Henning, Esq., *Toronto, Canada West.*
	State Survey and University, *Geological Rooms, Columbia, Mo., U.S.A.*
	G. C. Swallow, State Geologist, *Missouri, U. S. A.*
	Elliott Society of Natural History, *Charleston, S. C., United States* (per J. F. M. Geddings).
	German Geological Society, per Bessersche Buchhandlung, *Behren-str. 7, Berlin.*
	W. Haidinger, of Vienna, as Editor of the "Jahrbuch der K. K. Geologischen Reichsanstalt."
	Frankfort on the Maine—The Senkenbergische Naturforschende Gesellschaft.

No. III.

MEMBERS GAINED.

Life Members.

1. Crawford, Robert, Esq.
2. Carson, Rev. Joseph, D. D.
3. Green, John Ball, Esq.
4. Haughton, John Hancock, Esq.

Annual Members.

1. Baily, W. H., Esq.
2. Bolton, George, Esq., Jun.
3. Carte, Alexander, Esq., M. D.
4. Craig, G. A., Esq., C. E.
5. Dowse, Richard, Esq.
6. Frith, R. H., Esq., C. E.
7. Gordon, John, Esq., C. E.
8. Hampton, Thomas, Esq., C. E.
9. Kincaid, Joseph, Jun., Esq.
10. O'Meara, Rev. Eugene.
11. Phayre, George, Esq., C. E.
12. Porter, William, Esq., C. E.
13. Reeves, R., Esq.
14. Stack, Rev. Thomas.
15. Tait, Alexander, Esq., C. E.
16. Welland, William J., Esq.

LOST FROM DEATH AND OTHER CAUSES.

Annual Members.

1. Ball, Robert, Esq., LL. D.
2. Banks, John G., Esq., M. D.
3. Clarke, William, Esq.
4. Dawson, William, Esq.
5. England, Professor.
6. Kingsmill, Thomas, Esq.
7. M'Arthur, Alexander, Esq.
8. Scott, William, Esq.
9. Welland, Joseph, Esq.
10. Wilson, Robert W., Esq.
11. Worrall, John, Esq., C. E.

Associates.

1. Cochrane, D. C., Esq.
2. Fisher, John W., Esq.
3. Galwey, William, Esq.
4. Geoghegan, Jacob, Esq.
5. Grainger, John, Esq.
6. Griffith, James, Esq.
7. Gwynne, Robert, Esq.
8. Hewson, Francis, Esq.
9. Johnston, Alexander, Esq.
10. Kincaid, Joseph, Esq., Jun.
11. Maguire, John J., Esq.
12. Martin, Charles, Esq.
13. Martin, Thomas, Esq.
14. Richardson, John, Esq.
15. Townsend, Edward, Esq.
16. Waller, Arthur, Esq.
17. Warren, James, Esq.

		1857.	1858.
Honorary Members,		4	4
Honorary Corresponding Members,		3	3
Life Members,	51	52	58
Add omitted,	1		
Annual Members,	85	87	90
Add omitted,	2		
		146	155

Total gained, ... 20 Members.
„ lost, ... 11 „

nett gain, ... 9 „

	1857.	1858.
Associate Members,	21	4
Lost,	17	

No. IV.

DONATIONS RECEIVED DURING THE YEAR 1857-8.

1857.

Mar. 6.—Quelques Mots sur la Flora Tertiaire de L'Angleterre. Par M. Ph. Delaharpe, M. D. Presented by the Author.

Mar. 6.—Examen de l' Hypothese de M. D. Sharpe sur l'Existence d'une Mer Diluvium Baignant les Alpes. Par M. Ph. Delaharpe. Presented by the Author.

Mar. 6.—Minutes of Proceedings of Institute of Civil Engineers, Vols. IX., XII., XIV., and XV. Presented by the Institution.

Mar. 6.—Annual Report of the Geological Survey of the State of Wisconsin. By James G. Percival, Esq. Presented by J. A. Lapham, Esq.

April 8.—Quarter Sheets of the Geological Maps of Ireland. Twenty-one in number. Presented by the Director-General of the Geological Survey of the United Kingdom.

May 18.—Quarterly Journal of the Geological Society of London, No. 49. Presented by the Society.

May 18.—Journal of the Proceedings of the Linnæan Society, Vol. I., No. 4. Presented by the Society.

May 18.—Transactions of the Royal Scottish Society of Arts, Vol. IV., Part IV. Presented by the Society.

May 18.—The Canadian Journal of Industry, Science, and Art, for January, 1857, No. 7. Presented by the Canadian Institute, per Thomas Henning, Esq.

May 18.—Transactions of the Geological Society of London, Second Series, Vol. VII., Part IV. Presented by the Society.

May 18.—Proceedings of the Royal Geographical Society of London, No. 7. Presented by the Society.

May 18.—Forty-five Copies of the Society's Journal, Vol. VII., Part I. Presented by the Rev. Professor Haughton.

July 1.—The Canadian Journal of Industry, Science, and Arts, No. 1 to 8 inclusive. Presented by the Canadian Institution, per Thomas Henning, Esq.

July 1.—The American Journal of Science and Art, Nos. 61 to 69 inclusive. Presented by the Editor.

July 1.—The Quarterly Journal of the Geological Society of London, Nos. 47 and 48. Presented by the Society.

July 1.—Proceedings of the Royal Geographical Society of London, No. 8. Presented by the Society.

July 1.—Journal of the Proceedings of the Linnæan Society, Vol. II., No. 5. Presented by the Society.

July 1.—Journal of the Royal Geographical Society of London, No. 26. Presented by the Society.

July 1.—Proceedings and Papers of the Kilkenny and South-East of Ireland Archæological Society, Vol I., Nos. 7 and 8. Presented by the Society.

Nov. 2.—Proceedings of the Royal Geographical Society of London, No. 9. Presented by the Society.

Nov. 2.—Address delivered at the Anniversary Meeting of the Royal Geographical Society by Sir Roderick Murchison. Presented by the Author.

Nov. 2.—Proceedings and Papers of the Kilkenny and South-East of Ireland Archæological Society, Vol. I., Nos. 9 and 10. Presented by the Society.

Nov. 2.—The Quarterly Journal of the Geological Society of London, No. 51. Presented by the Society.

Nov. 2.—The Canadian Journal of Industry, Science, and Art, Nos. 9, 10, and 11. Presented by the Canadian Institute, per Thomas Henning, Esq.

Nov. 2.—The American Journal of Science and Arts, Nos. 70 and 71. Presented by the Editor.

Nov. 2.—The Proceedings of the Zoological Society of London, Nos. 310 to 333. Presented by the Society.

Nov. 2.—Report of the Twenty-sixth Meeting of the British Association for the Advancement of Science, held at Cheltenham, August, 1856. Presented by the Association.

Nov. 2.—500 Lithographic Plates of the Permian Fossils. Presented by the Rev. Professor Haughton.

Nov. 7.—The Pick and Gad: a Monthly Record of Mining, No. I., November. Presented by W. Arundell, Esq.

Nov. 7.—Proceedings of the Elliott Society of Natural History of Charleston and Carolina, from November, 1853, to April, 1857. Presented by the Society.

Dec. 9.—Proceedings of the Zoological Society of London, Nos. 334 to 338. Presented by the Society.

Dec. 9.—Journal of the Proceedings of the Linnæan Society, Vol. II., No. 6. Presented by the Society.

Dec. 9.—Transactions of the Historic Society of Lancashire and Cheshire, Vol. IX. Presented by the Society.

Dec. 9.—Commerce of the Medial East. By John Locke, A. B. Presented by the Author.

Dec. 9.—Notices of the Meetings of Members of the Royal Institution of Great Britain, Part VII. Presented by the Institution.

Dec. 9.—Proceedings and Papers of the Kilkenny and South-East of Ireland Archæological Society for September, 1857. Presented by the Society.

Dec. 9.—Transactions of the Academy of Science of St. Louis, Vol. I., No. 1. Presented by the Academy.

Dec. 9.—The American Journal of Science and Art, No. 72. Presented by the Editor.

Dec. 9.—The Quarterly Journal of the Geological Society of London, No. 52. Presented by the Society.

Dec. 9.—Address delivered at the Anniversary Meeting of the Geological Society of London by Col. J. E. Portlock, R. E. Presented by the Author.

Dec. 9.—Proceedings of the Literary and Philosophical Society of Liverpool, No. 11. Presented by the Society.

Dec. 9.—Annual Report of the Plymouth Institution and Devon and Cornwall Natural History Society for 1855 and 1856. Presented by the Institution.

Dec. 9.—Ditto, ditto, for 1856–7.

Dec. 9.—Report on the Geology of Newfoundland. By J. Beete Jukes, Esq., M. A. Presented by the Author.

Dec. 9.—The Natural History Review and Quarterly Journal of Science. Vol. IV. Presented by the Editor.

Dec. 9.—Tenth Annual Report of the Smithsonian Institution for 1855-6. Presented by the Institution.

Dec. 9.—List of Corresponding Members of the Smithsonian Institution. Presented by the Institution.

Dec. 9.—List of Works published by the Smithsonian Institution.

Dec. 9.—Brief Extracts from Memoranda of the Earl of Dundonald on the Use, Properties, and Products of the Bitumen and Petroleum of Trinidad. Presented by the Author.

Dec. 9.—Proceedings of the Academy of Natural Sciences of Philadelphia, from July, 1856, to March, 1857. Presented by the Academy.

Dec. 9.—Catalogue of the Human Crania in the Collection of the Academy of Natural Sciences of Philadelphia. By J. Aitken Meigs, M. D. Presented by the Author.

Dec. 9.—Illustrations of Surface Geology. By Edward Hitchcock, LL. D. Presented by the Author.

Dec. 9.—New Edition of the Geological Map of Ireland. By R. Griffith, LL. D. Presented by R. Griffith, LL. D.

Dec. 16.—Miller's Natural History of Crinoidea. Presented by the Geological Society of London.

Dec. 16.—The Geology of Massachusetts. By E. Hitchcock, LL. D. Presented by the Geological Society of London.

Dec. 16.—Recherches sur les Volcans Etients du Vivarais et Du Velay. Presented by the Geological Society of London.

Dec. 16.—Traité de Minéralogie. Par C. C. Haüy, Vols. I., II., IV., and V. Presented by the Geological Society of London.

Dec. 16.—Buckland's Geology and Mineralogy, Vols. I. and II. Presented by the Geological Society of London.

Dec. 16.—Stevens' Mineralogy of Dublin. Presented by the Geological Society of London.

Dec. 16.—Woodward on Fossils. Presented by the Geological Society of London.

Dec. 16.—Watson's Derbyshire Strata. Presented by the Geological Society of London.

Dec. 16.—Martin's Fossils of Derbyshire. Presented by the Geological Society of London.

Dec. 16.—Martin on Fossils. Presented by the Geological Society of London.

Dec. 16.—History of the Extinct Volcanos of the Basin of Neuwied, on the Lower Rhine. Presented by the Geological Society of London.

Dec. 16.—Charpentier's Essai sur la Constitution Géognostique des Pyrénées. Presented by the Geological Society of London.

Dec. 16.—Illustrations of the Huttonian Theory of the Earth. By John Playfair. Presented by the Geological Society of London.

Dec. 16.—Rapport sur les Poissons Fossiles. Par L. Agassiz. Presented by the Geological Society of London.

Dec. 16.—Geognostische Untersuchung des Sud-Ural Gebirges. By Hoffman and Heleison. Presented by the Geological Society of London.

Dec. 16.—Geologie der Westlichen Schweizer Alpen. By B. Studer. Presented by the Geological Society of London.

Dec. 16.—Caractéres Minéralogiques. Par Le C. Haüy. Presented by the Geological Society of London.

Dec. 16.—Geognostische Karte Tirols. Presented by the Geological Society of London.

1858.

Jan. 8.—The Student's Manual of Geology. By J. Beete Jukes, M. A., F. R. S. Presented by the Author.

Jan. 8.—The Transactions of the Plymouth Institution. Presented by the Institution.

Jan. 8.—Proceedings of the Natural History Society of Dublin. Session 1856–7. Presented by the Society.

Jan. 8.—The Canadian Journal of Science and Art, No. 12. Presented by the Canadian Institution.

Jan. 9.—The Pick and Gad, No. 2, December. Presented by W. Arundell, Esq.

Jan. 9.—The Report of the Proceedings of the Geological and Polytechnic Society of the West Riding of Yorkshire. 1856–7. Presented by the Society.

Jan. 9.—The Thirty-seventh Report of the Council of the Leeds Philosophical and Literary Society. 1856–7. Presented by the Society.

Jan. 9.—The Athenæum for the year 1857. Presented by the Editors.

Jan. 9.—The Literary Gazette for the year 1857. Presented by the Editors.

Jan. 9.—Geological Map of Canada and Hudson's Bay Territories. By Thomas Devine. Presented by J. B. Greene, Esq., Superintendent, General Valuation, Ireland.

Jan. 9.—Report upon the Mineral and Geological Structure of South Namaqualand and the adjoining Mineral Districts. By Andrew Wyley, Esq. Presented by the Author.

No. V.

ABSTRACT OF THE TREASURER'S ACCOUNT FOR THE YEAR ENDED DECEMBER 31, 1857.

Dr. 1857.	£ s. d.	£ s. d.
To Amount of Grant from the Provost and Fellows of Trinity College, omitted to be entered in last year's Account,		25 0 0
— Life Composition,	£55 0 0	
— Admission Fees,	11 0 0	
— Annual Subscriptions,	80 5 0	
		146 5 0
— Sale of Journals,	2 3 0	
— Do. Admission Tickets,	0 15 6	
		2 18 6
		£174 3 6

Cr. 1857.	£ s. d.	£ s. d.
By Balance due Treasurer, as per last Account,		4 19 2
— Cash paid Editors of "Natural History Review,"	5 0 0	
— Mr. Gill's Account for Printing, (per Draft 10,278),	4 14 7	
		9 14 7
— Sundries, per Assistant Secretary,	3 17 8	
— Paid by Gratuity to Attendant, (per Draft 10,279)	1 10 0	
		5 7 8
— Editors of "Natural History Review" to July 1, (per Draft 10,280),		12 10 0
— Books bought at the late Dr. Ball's sale (per Draft 10,281),		5 7 0
— Sundries, per Assistant Secretary,	7 8 1	
— Mr. Keogh's Account for Binding,	2 12 3	
— Mr. Tallon's Account for Stationery,	1 8 6	
— Half-year's Salary to Assist. Secretary, (per Draft 10,282),	10 0 0	
		21 8 10
— Editors of "Natural History Review," to December 31, 1857 (per Draft 10,283),		12 10 0
— Sundries, per Assistant Secretary (per Draft 10,284),		12 9 7
— Mr. Gill's Account for Printing (per Draft 10,285),		8 2 0
— Half-year's Salary to Assistant Secretary, (per Draft 10,286),		10 0 0
		102 8 10
— Balance in Bank,	£66 14 8	
— Cash in hands,	5 0 0	
		71 14 8
		£174 3 6

Accounts examined and found correct, leaving a balance of £71 14s. 8d. to credit of Society,

SAMUEL GORDON,
JOHN ROBERT KINAHAN,
TALBOT DE MALAHIDE.

February 3, 1858,

The ballot was then opened, and the following declared duly elected:—

PRESIDENT.—Rev. Professor Haughton, M. A., F. T. C. D.

VICE-PRESIDENTS.—James Apjohn, M. D.; Professor Harvey, M.D., F. L. S.; Rev. Humphrey Lloyd, D. D., S. F. T. C. D.; Sir Richard Griffith, Bart., LL. D.; Lord Talbot de Malahide, F. R. S.,

TREASURERS.—Gilbert Sanders, Esq.; F. J. Sidney, LL. D.

SECRETARIES.—J. Beete Jukes, M. A., F. R. S.; E. Percival Wright, M. B.

COUNCIL.—Robert Mallet, Ph. D.; Edward Wright, LL. D.; Robert Callwell, M. A.; Rev. J. A. Galbraith, F. T. C. D.; John Kelly, Esq.; George M'Dowell, M. A., F. T. C. D.; Samuel Downing, C. E., LL. D.; John B. Doyle, Esq.; Dominick M'Causland, Esq.; John R. Kinahan, M. D.; G. V. Du Noyer, Esq.; Alexander H. Haliday, M. A., F. L. S.; Rev. Joseph Carson, D. D., F. T. C. D.; Alexander Carte, M. A., M. B.; John Ball Greene, Esq.

The Society then adjourned till 9 o'clock.

ADJOURNED ANNIVERSARY MEETING, FEBRUARY 10, 1858.

LORD TALBOT DE MALAHIDE in the Chair.

THE following addition to the By-Laws was proposed and adopted:—

"Any person residing as above, who shall have paid an admission fee of £5, shall be at liberty to compound for his annual subscription of 10*s*., by the payment of a further sum of £5."

Charles Cotton, Esq., University Club, Stephen's-green, was proposed by Professor Haughton, and seconded by Professor Galbraith.

Lord Talbot de Malahide then read his Annual Address, at the conclusion of which he retired from the Chair, which was then taken by Professor Haughton.

A vote of thanks to Lord Talbot for his distinguished services to this Society during his Presidency was moved by Dr. Apjohn, which was seconded by Professor Galbraith, and carried by acclamation.

Dr. Wright moved, and D. M'Causland, Esq., seconded, that the Address be printed. Carried.

The Society then adjourned to March.

ANNUAL ADDRESS.

GENTLEMEN,—Our Society was formed in 1831, and has continued ever since with varied fortunes, but with a constant accession of scientific strength. I believe I can congratulate you on the prospect of increased efficiency, and of a larger sympathy on the part of the public. I feel it a high honour to have been elected for three years to fill this Chair, particularly as it fell within my functions to preside at the Geological Sec-

tion of the British Association during their meeting in this city, one which has equalled most of its predecessors in brilliancy and interest. However, it is right that a change of officers should take place, and I rejoice to find that so distinguished a philosopher as Professor Haughton has consented to act as President during the current year. Although my other vocations may prevent me from attending the meetings as often as I could wish, I shall always be most anxious to watch the progress of the Society, and to assist it in every way that lies in my power. The Report of the Council contains all the statistical facts relating to our numbers and our finances; and here I shall confine myself to urge upon every member the importance of his acting as a recruiting-sergeant to enlist all likely persons,—not holding out to them, however, a reduced standard, but the prospects of glory in the fields and battles of our warlike science.

Fortunately, we have not to deplore the loss of so many of our members as during the last year; but there is one which I cannot pass over without enlarging somewhat upon this melancholy theme, as he was one of our oldest, most zealous, and useful friends. For many years I have been on terms of intimacy with him, and to him I owe what interest I have taken in the pursuit of Zoology.

Dr. Ball was a native of the county of Cork, and thanks to his friend, Mr. Robert Patterson, we have a detailed account of his career in the last number of the "Natural History Review." I shall, therefore, on the present occasion be more brief than I should otherwise have been.

He was born at the Cove of Cork, in 1802. His family lived at Youghal, and there he spent those parts of his youth which were not devoted to school. He appears to have been a self-taught naturalist, and Mr. James White, of Ballitore, at whose school he was principally instructed, encouraged this propensity. It is much to be regretted that he was not enabled to follow some independent profession, instead of being bound during all his active life by the trammels of office. He doubtless could have distinguished himself in almost any line. It was through the influence of his kind patron, the late Duke of Devonshire, he obtained, in 1827, the clerkship in the Castle of Dublin, which he retained until his superannuation in 1852. A more indefatigable public servant never existed, nor one more intelligent and faithful to his trust; and I venture to say that there is not a more disgraceful specimen of the bureaucratic style than the following sentence:—Mr. Ball is placed on the retired list on the ground "that he devoted much attention to scientific pursuits, and that it was not expedient that public servants should be thus occupied." Before this time, and subsequently to his superannuation, he was busily engaged in other public departments that had not the same antipathy to science. In 1851 he was appointed Secretary to the Queen's University; in 1854, Secretary to the Joint Committee of Lectures; in 1855, Assistant Examiner for Ireland to the Civil Service Commission; and he continued this arduous duty till the close of his life.

He acted as Secretary to the Dublin Zoological Society for more than twenty years, and it is mainly owing to his exertions that this useful

body was kept alive during the years of famine and difficulty, amid the apathy of the Irish public. It must have been a heartfelt gratification to him to see it placed at last on a secure and firm basis by a small Government grant of £500 a year, which it at present receives.

In 1853 he was the founder of the University Zoological and Botanical Association, which has been so useful a recruiting body of young and zealous naturalists.

Dr. Ball was elected a Member of the Royal Irish Academy in 1835, and a Member of Council in 1838. He acted for many years, and died Treasurer of that distinguished body.

He was elected a Member of the Royal Dublin Society in 1834, and in 1854 a Member of Council; he was also a Member of the Council of the Statistical Society from its foundation in 1847.

He joined our Society in 1835, and was always an active member. In 1837 he was elected on the Council, and in 1852, President. We are also greatly indebted to him for his unremitting support during those dreadful years when society itself seemed rocking at its base. His extensive knowledge of Natural History was of great value, particularly when Palæontology assumed its proper position as the right-arm of Geology. His courtesy and affectionate demeanour to all was most remarkable, and only to be equalled by his great modesty. In the "Journal" of our Society he wrote occasionally in illustration of those questions where Natural History throws light on Geology; but it is much to be regretted that he had so little time and leisure to mature and perpetuate the information with which his mind was stored.

It was chiefly through his exertions that we were induced to offer our Collection to the University of Dublin. It now forms the nucleus of that noble Museum. Dr. Ball was appointed Curator, and during many years devoted a considerable portion of his leisure to its classification, and the preparation of numerous valuable specimens and casts. The skeletons of the *Cervus megaceros* are the most complete in existence, and evince his great skill in the art of museum arrangement.

He was appointed President of the Zoological Section of the last Meeting of the British Association; but it was not the will of God that he should witness another meeting of that body. He died suddenly on the 30th of March, and most of us had the melancholy pleasure of accompanying his remains to Mount Jerome Cemetery.

He has left a chasm in our ranks which will not be easily filled. May his surviving family enjoy every kind of prosperity, and may his sons follow in his steps!

I think the most convenient course for me will be to notice briefly the most remarkable papers which were submitted to our Section of the British Association. There are some few notices of a general nature which I may introduce in a separate paragraph, and I will reserve to a later period the discussion of some of those intestine questions which have produced so much interest on this side of the channel. I do not conceive that I am called on to give anything like a general view of the progress of Geology in other countries, as we know the conscientious

manner in which the present President of the London Geological Society discharges this arduous duty.

As far as Geology was concerned, we have every reason to be satisfied with the intellectual fare which was provided for us. There was a goodly gathering of congenial spirits; and although, to my deep regret, we missed the well-known and revered faces of Buckland, of Delabeche, of Conybeare, of Greenough (who no longer belong to this earth), and also of a Sedgwick, a Murchison, and a Lyell, we were gratified with the opportunity of making the acquaintance of many of the young and rising followers of the science, and some of the celebrities of America and Continental Europe. Above all, it must have afforded you all the sincerest pleasure to welcome again to these shores General Portlock and Mr. Oldham, who both filled this Chair with such success, and who now, as you are doubtless aware, are respectively placed in the honourable and responsible situations of President of the Royal Geological Society of London, and Director of the Geological Survey of India.

We have been honoured by the visit of Messrs. Schlagintweit, who have been so long engaged under the King of Prussia and the East India Company, to their mutual honour be it spoken, in investigating the natural history and physical peculiarities of India; also, of the two Professors Rogers, who have imparted to us such valuable and novel information on the geological structure of the United States of America, particularly in relation to the Geological Map of Pennsylvania which has been prepared under their direction; and Professor Mallet, who has exhibited and explained that truly masterly production, the Geological Map of the State of Alabama.

Mr. Fox's paper on the "Temperature of Mines," forms the sequel to a series of observations, which, for the last twenty years and upwards, has occupied his attention. It is truly refreshing to see such long sustained perseverance in the pursuit of scientific truth.

Sir Roderick Murchison, though not with us corporally, has sent us a valuable paper on the crystalline rocks of the N. W. Highlands, which he proves on fossil evidence to be of lower Silurian age.

Professor Harkness continues his observations on the triassic formation of the south of Scotland and N. W. of England, which appears to harmonize more with the continental deposits than any other within these isles. He also read papers on the lower sedimentary rocks of Cumberland, and on the dolomitization of rocks in the vicinity of Cork.

Professor Phillips gave us one of his graphic sketches of the ironstone beds of the Olites of Yorkshire.

Professor W. B. Rogers exhibited some good photographs of that peculiar and characteristic Palæozoic fossil, the Paradoxides.

I beg to call your particular attention to our member, Mr. Robert Mallet's "Report on Earthquakes." He has for many years studied these phenomena, and explained them by those great cosmical theories to which the powers of analysis and pure mathematics have been so successfully applied. We must all rejoice to hear that he has been dispatched, under the sanction of the Royal Society, to inquire into the circumstances

attending the almost unexampled physical disturbances in Southern Italy.

Another great question in Physical Geology, the subject of slaty cleavage, has also been well discussed. Professor Sedgwick and Mr. Sharpe have long since propounded theories to explain these properties of rocks. But it is only within a recent period that the Baconian system of induction has been systematically brought into action in order to afford a rational solution of them. Mr. Sorby has most minutely examined slaty rocks under a powerful microscope of 400 linear, and he comes to the conclusion that pressure in a direction perpendicular to the direction of the cleavage planes is sufficient to account for these problems. He observes:—"In cleaved rocks, whether we examine the diminution in distance between any two points lying in the line of pressure in contorted beds, the dimensions of the beds in different parts of contortions, the organic remains, the green spots, or the very minute rounded grains of mica, we find most conclusive evidence of an elongation in the line of dip of cleavage, and of a great compression invariably in a line perpendicular to the cleavage."

Professor King has also confirmed this view by comparison with the views observed in crystallized minerals.

Professor Haughton also has come to a similar conclusion, by a study of the distortion to which fossils are so frequently liable in slaty rocks. He has accurately measured the angles which they form to the planes of cleavage, and has thence deduced the following laws:—

1st Law.—If the trace or intersection of the plane of cleavage and plane of bedding be drawn, the greatest distortion or elongation of the fossils lying in the plane of bedding is parallel to this intersection.

2nd Law.—The distortion of fossils produced by cleavage, estimated in a given direction, such as parallel to the intersection of the planes of cleavage and bedding, varies with the angle between these planes, being greatest when the angle is greatest, and least when the angle is least.

3rd Law.—The compression in a cleaved rock is greatest in a direction perpendicular to the planes of cleavage.

These positions are illustrated in the Rev. Professor's papers by some very interesting drawings of distorted fossils from the Carboniferous Limestone.

Professor H. D. Rogers, however, does not entirely subscribe to these views, for in a learned paper by him, published in the Transactions of the Royal Society of Edinburgh, "On the Laws of Structure of the more disturbed zones of the earth's crust," he adheres rather to the theory of Professor Sedgwick, and conceives that "cleavage is a change brought about by the parallel transmission of planes or waves of heat, awakening the molecular forces and determining their direction."

Mr. Hopkins has also contributed some experimental researches on the conductive powers of various rocks, and the bearing of the results upon theories of terrestrial temperature. It is by the accumulation of such facts as these that we shall ultimately be led to the construction of a true and philosophical theory of the earth.

It is satisfactory to find one of our Professors, Mr. Hennessy, grappling with one of these arduous questions of mixed mathematics, and attempting to calculate the forces capable of changing the sea-level during different geological periods. Arguing on the supposition that the crust of the earth underwent a change of volume on the gradual cooling of its surface, and that a change of the ellipticity would be the consequence, he concludes that a very considerable alteration of the sea-level would be the inevitable result.

Mr. Oldham gave us a general view of the geology of India. It is a gigantic subject, and the great scale on which the principal formations in that country are to be seen must ultimately be most important to the progress of our science. We are under the greatest obligations to the late Mr. Greenough, one of whose last works was the publication of his Map of India; like the similar Map of Great Britain, it will form the groundwork for all future inquirers. But in so vast a country, and one which contains so many large tracts, as yet but little known to the natives themselves, it will require many years of careful exploration before the true nature and extent of the different strata can be accurately determined. Mr. Oldham's work has, doubtless, been arrested by the deplorable events which have recently occurred in that country, but we must hope that general tranquillity will soon be restored, and that the Sepoy will soon rank with the Sivatheria and other extinct animals.

We are also indebted to the Cavaliere Meneghini for an interesting paper on the Palæontology of Tuscany. Itself the birthplace of this branch of our science, it appears that there are not wanting patient inquirers to assist Professor Sair in following up and correcting the conclusions of the distinguished Brocchi.

Mr. R. Goodwin Austen, whose researches on the chalk and underlying formations have created such interest, favoured us with a communication on the occurrence of a granite boulder in the chalk.

Dr. Kinahan, the Rev. Mr. Symons, Mr. Baily, Mr. Salter, Mr. Page, have made some valuable palæontological communications.

Palæontology is now assuming so important a position in the world of science, and so many valuable discoveries are continually rewarding the researches of our English friends, that it may not be uninstructive to enumerate some of the more remarkable results during the past year.

Professor de Mulot describes the discovery, by Messrs. Uhlmann and Jahn, of remains of the gigantic elk (*Cervus euryceros* or *megaceros*), in association with the works of human industry. They were found in 1856, near a small lake near Mooscedorf (Canton of Berne), which was being drained, in a bed of peat three or four feet thick, together with fragments of pottery, stone chisels, stone arrow-heads, pieces of cut bones, and perforated bears' teeth, without any trace of metallic objects, and also carbonized grains of barley. There were also found in the same locality many fragments of bones both of domesticated and wild animals, viz., horned cattle, horses, swine, dogs of various sizes, goats, sheep, cats, elks, stags, aurocks, bears, wild boars, foxes, beavers, tortoises, as well as several birds and other animals still undetermined.

These details are interesting in order to determine the age of this animal, which appears to have evinced so remarkable a partiality for the climate of this country.

Captain Spratt, R. N., discovered in a tertiary formation at Salonica, of fresh-water origin, some fossil vertebræ of a serpent. Professor Owen considers it an extinct species, different from any of those existing at present in the south of Europe; and that it was between ten and twelve feet in length. The vertebræ offer many points of resemblance to those of the rattlesnake and viper, but there are no certain grounds for the conclusion that it was a poisonous reptile. The traditions of ancient Greece point to large serpents, and the discovery of these remains suggests the importance of attempting to trace in the superficial deposits of that country evidences of the existence of the lion or other large beasts of prey, which Hercules and the other heroes are said to have destroyed.

Professor Owen describes some bones of the *Dichobure ovina*, an anoplotherioid quadruped from the upper eocene marl of the Isle of Wight; also some remains of the *Dichodon cuspidatus*, an extinct mammal from the eocene sand of Hudwell, Hants, and also at Alum Point, in the Isle of Wight.

Dr. Falconer describes two species of Plagiaulax from Purbeck. This is a marsupial animal, and is only one among many species of extinct mammalia, the exuviæ of which have been found in the dirt-bed of Purbeck. It is to be hoped that this locality will be adequately examined and illustrated, as Mr. Beccles, resident there, is a most valuable practical explorer, and a systematic discription of the remains found there by Professor Owen would be of the utmost value. To omit minor discoveries, Messrs. Wyville Thomson and Salter describe several new varieties of the Acidaspis from the Silurian strata of Ayrshire and Shropshire.

Mr. J. W. Kirkby also describes some curious Crustaceans and Chitons from the Permian strata of Durham.

I cannot conclude this part of the subject without alluding to the remarkable paper by Dr. Falconer, read before the London Geological Society, on the different species of Mastodon, particularly those found in the British strata. He draws a marked distinction between the *Mastodon angustidens* and *Mastodon arvernensis*, contrary to the views of Cuvier and Owen. The former he considers peculiar to the *miocene* strata, the latter to the *pleiocene*. He further concludes:—

1. That the *Mastodon* remains, found both in the *fluvio-marine* or *Norwich crag*, and *red crag*, belong to the *pleiocene* form, *Mastodon* (*tetralophodon*) *arvernensis*.

2. That the mammalian Fauna of the *fluvio-marine crag* bears all the character of the *pleiocene* age, and is identical with the *sub-Appennine pleiocene* Fauna of Italy.

3. That the *red* and *fluvio-marine* crags, tested by their mammalian Fauna, must be considered as beds of the same geological age.

It is very much to be desired that Dr. Carte, or some person equally well qualified, would undertake the publication of a monograph of the Irish fossil mammalian remains.

I shall now touch upon some subjects more closely connected with Irish Geology; and, in the first place, I rejoice to find that Professor Haughton is not relaxing in his inquiries as to the mineral composition of the Irish rocks.

He read to us a paper on the Siliceo-felspathic Rocks of the south of Ireland, which affords some remarkable results. These rocks are situated in the mining district of Ovoca, and county of Wicklow; in the district of Bonmahon, county of Waterford; and also in the neighbourhood of Killarney and Kenmare Bay, in the county of Kerry. They resemble much in chemical composition, though not in appearance, the *elvans* of Cornwall, and the miners consider that they have an equally favourable effect on the mineral lodes. They are, however, frequently deposited in stratified beds, conformable to the slates and felspathic ash-beds in which they are situated. Professor Haughton has analyzed with his usual care several specimens of these rocks, and the conclusions he comes to are as follows:—

	Per cent.
Bell Rock, Vale of Ovoca—Quartz, ...	45·54
,, ,, Orthoclase felspar, ...	54·16
	99·70
Rocks of Bonmahon, Co. Waterford—Quartz, ...	40·81
,, ,, Orthoclase felspar,	57·19
,, ,, Carbonate of lime,	1·81
	99·81
Benaunmore, county of Kerry.	
This rock is columnar trap—Quartz, ...	20·51
,, ,, Orthoclase felspar, ...	77·85
	98·36

Professor Haughton mentions, in connexion with these rocks, a fact of great interest to the student of Irish antiquities and ethnology. On examining, with Mr. Wilde, the collection of stone implements in the Museum of the Royal Irish Academy, these siliceo-felspathic rocks appear to have been carefully sought out by the makers, and there are very few specimens in that large collection which cannot be identified as made of Irish rock. There are, however, some stone implements from Jamaica, formed of the same kind of stone, which, for its hardness and toughness, would appear to be peculiarly adapted for such purposes.

Mr. Du Noyer read a paper on the Junction of the Slate and Granite at Killiney.

Dr. Clarke, a paper on the Alterations of Local Level near Waterford.

Mr. Baily, a detailed account of the Fossils collected by the Geological Survey in the Carboniferous Rocks of the county of Limerick.

Mr. Wynne, on the Structure of the Galtees.

Mr. G. H. Kinahan, on the Trap of Valentia Island; and Dr. Kinahan, on the Zoological Relations of Bray Head and Howth. These were all interesting papers, particularly the latter.

There has been, as all geologists are aware, considerable discussion as to the subdivision of the Carboniferous System of Ireland. Until lately, Dr. Griffith's classification of these rocks was undisputed; but Mr. John Kelly has lately given great attention to the subject, and I am sure that you will not consider your time wasted in considering the arguments on both sides of this important question.

Mr. John Kelly, in a paper read before this Society, considers that the—

1. Old Red Sandstone,
2. Carboniferous System (Carboniferous Slate, &c.),
3. Limestone,
4. Coal series,

are all subdivisions of one great formation, in the ascending order, in which the whole series from the beginning to the end was deposited, without any great catastrophe in the succession. They are all parallel one to the other; they rest unconformably on the inferior or underlying rock, and are covered unconformably by the overlying rock; the fossil evidence also confirms this view, as the lowest member of this formation, the Old Red Sandstone, contains organic remains common in the mountain limestone.

In this formation there is not included a deposit, called by Mr. Kelly, *Brownstone*, and which has been associated with the Old Red Sandstone or Devonian rocks of the English geologists. Mr. Kelly considers this rock to form a connecting link, if not an actual member, of the Silurian Palæozoic rocks, and to be in no way connected with the true Old Red Sandstone.

This forms one part of Mr. Kelly's maxim, and here there is not much difference of opinion.

In the next place he refers to Dr. Griffith's subdivision of the true Carboniferous rocks.

Dr. Griffith divides them as follows, in the ascending order:—

1. Yellow Sandstone.
2. Lower Limestone.
3. Calp, alternating with black shale and sandstone, and said to be at Bundoran 1700 feet in thickness.
4. Upper Limestone.

Mr. Kelly considers that there are good grounds for interpolating a series of Carboniferous Slates between the *Limestone* and *Old Red Sandstone*, which would correspond with the *Yellow Sandstone* of Dr. Griffith; but he thinks that there should be only one *Limestone*, and he utterly objects to the existence of the *Calp*.

In order to make out these propositions, he contends, on stratigraphical grounds, that the two limestones are one, separated by a succession of faults, and that the *Calp* in the neighbourhood of

Bundoran is a portion of the *Old Red Sandstone*. The great mass of *Calp* described in Dr. Griffith's Geological Map as extending over the Slievebeagh mountains from Dungannon to Lisnaskea, he places in the coal-measures, as he does also the *Calp* of the counties of Dublin, Meath, Kildare, and Westmeath, and also of the south of Ireland. His arguments chiefly apply to the vicinity of Bundoran, and both he and Dr. Griffith seem to have placed the result of the issue chiefly on the result of an examination of the carboniferous rocks in that district and in the N. E. corner of Lough Erne. Mr. Kelly has traced what he considers to be the line of the *Old Red Sandstone*, and contends that throughout, where the shales and sandstones of the Calp are introduced, there is ground for supposing that they belong to that formation, and underlie the true *Carboniferous* System. The difference of level between the limestones north and south of Bundoran he ascribes to a great fault which has thrown down the northern strata to the extent of nearly 1500 feet. As a proof of this he adduces the difference between the level of the base of the Millstone Grit on Sheanhill, on the south side of Lough Erne, and the same rock at Portinode, on the north side. The actual difference of level would be about 1000 feet, and he calculates that, in consequence of the rock dipping south, there is a downfall of about 1500 feet.

The lithological character of this formation appears to vary so much in different localities, and it has been subject to so many metamorphic agencies, that on this ground it would be difficult to find any safe ground of distinction. It is to be regretted that Mr. Kelly has not made more use of fossil evidence in order to elucidate this intricate subject.

Dr. Griffith, in his reply to Mr. Kelly with respect to the great fault alluded to says:—

"No doubt there is a fault of trifling character, having a *north and south direction*, visible near the coast of Bundoran; but in this case the strata on both sides belong to the same Calp series, while its north and south direction contributes nothing towards sustaining Mr. Kelly's assumption of the great fault extending westward from Lough Erne to the sea coast near Bundoran; and the only argument he has brought forward in support of his opinion is, that the level of the Millstone Grit at Sheanhill, on the south side of Lough Erne, is 1135 feet above the sea, while the Millstone Grit on the north side of Lough Erne is only 150 feet above the sea; and, arguing on this difference of level of 985 feet, he assumes that a downthrow of about 1000 feet has taken place between the north and south shores of Lough Erne. But Mr. Kelly's basis for the argument has no foundation, because the strata on the north side of Lough Erne consist of *Yellow Sandstone* and not *Millstone Grit*."

As I am not aware of any answer from Mr. Kelly to this statement, I presume it sets at rest this part of the question.

Dr. Griffith, in further confirmation of this theory, gives some very instructive sections:—

1. From Butler's Bridge, county of Cavan, and extending westward by Belturbet to Slieve Rushan Mountain, crossing Cuilcagh Mountain, the valley of the Shannon, Lackagh and Benbo Mountains, and termi-

nating at the sea-shore at the western base of Benbulben Mountain. This extends for fifty miles.

In this case we have a succession of concentric circles, each surrounding the other, in an ascending order from the Lower Limestone by the Calp to the Upper Limestone.

2. Another section gives the district between Bundoran and Ballyshannon, and exhibits a similar overlapping of the Carboniferous strata round Dartree Mountain.

3. In order to disprove Mr. Kelly's views with respect to Slievebeagh mountains, Dr. Griffith exhibits a section from Lisbellaw, in the Silurian strata, across the valley of Clogher, thence over the Slievebeagh Mountains, it then crosses the Carboniferous Limestone valley of Monaghan, terminates in the Silurian strata of Scot's House, west of the town of Monaghan. This section very clearly demonstrates the relative position of the Carboniferous beds.

Professor Jukes, in his paper on the Calp of Kilkenny and Limerick, strongly confirms Dr. Griffith's views with respect to those rocks by him called *Calp*, and by Mr. Kelly ascribed to the coal-measures.

He divides the Carboniferous System of Limerick and Kilkenny into three divisions, of which *Calp* forms the central one. It is distinguished from the other two by its black colour, the others being gray; it also contains but few fossils, those that are found in it resemble in character those found in the upper and lower rocks. A section through Gowran would give the following results:—

	Feet.
Thickness of the Limestone, ...	1000
Middle or Calp Limestone, ...	100
Lower Limestone, ...	1000

Another section between Pallaskenry and Foynes would give:—

	Feet.
Upper Limestone, ...	250
Calp, ...	1400
Lower Limestone, ...	1500

Professor Jukes suggests that the great thickness of the Dublin Calp may be owing to the thinning out of the upper Limestone, and that the coal-measure shales may rest on the Calp of the central counties without the intervention of any upper Limestone.

I think there can be now very little doubt of the existence of the Calp, and although we may be compelled to differ with Mr. Kelly as to his views on this subject, we must feel obliged to him for the independent manner in which he has stated his opinions, and for having brought to the test of discussion the accuracy of one of the most important land-marks in Irish geology. We all owe a deep debt of gratitude to Dr. Griffith for his Map of Ireland, and the multifarious information which he has given us upon all subjects connected with it.

Messrs Jukes and Du Noyer contributed to the Geological Section two joint papers:—

1. On the geology of an interesting neighbour, Lambay. Although noticed some years since by Mr. Hamilton, its structure, I believe, was never before minutely and accurately described.

2. On certain rocks found between the bays of Tralee and Bantry.

This latter paper has reference to a subject brought before the Association by Dr. Griffith, and there are also two other papers, one by Mr. Wynne, on the Galtees, and another by Mr. Joseph O'Kelly on a section across Slievenamuck Mountain, which have a very close connexion with Dr. Griffith's paper.

On the sedimentary rocks of the south of Ireland, some beautiful illustrative sections were exhibited at the meeting.

It appears, in the words of Dr. Griffith, that the *Old Red Sandstone* strata, consisting of alternate beds of red and green shales, red sandstones and conglomerates extend more or less continuously in an east and west direction, through the counties of Tipperary, Limerick, and Cork. We find the *Old Red Sandstone* lying conformably below the *Lower Limestone* and *Yellow Sandstone* of the Carboniferous System, and resting on the upturned edges of the Silurian rocks in an unconformable position, till, reaching the Old Red strata in the county of Kerry, they are found preserving the same relative position to the brownish-red grits, and the red, green, and purple clay-slates of the Dingle district which conform to and overlie the fossiliferous Silurian rocks of Ferriter's Cove; these being again overlaid unconformably on the western shore at Sybil Head by the beds of the Old Red series.

Dr. Griffith considers that these Old Red Sandstone beds should be associated with the *Carboniferous* System, to which they are conformable, rather than the *Devonian* System, which can hardly be said to have been yet found in Ireland. In this view all the working geologists of Ireland seem to agree.

There is, however, very great difficulty in determining the age of the grits and slates on which these rocks rest in the Dingle district. They are conformable to strata at Ferriter's Cove, which have been proved distinctly to be Upper Silurian from the fossils contained in them, but they resemble in appearance and composition the grits found to the south of Castlemaine Harbour, and which have been called by Professor Jukes, the *Glengariff Grits;* and these grits are quite conformable to the shales of the Old Red Sandstone and the beds of the Carboniferous System which overlie them. This is a difficulty which as yet has received no solution, and presents one of the greatest puzzles in all local geology; and, notwithstanding all that has been said and written on this subject, I cannot conclude better than by recommending our enterprising and earnest young friends to hasten with the fine season to the south of Ireland, and to work at these mountains until their history is clearly unravelled and explained.

ON A FOSSIL ELEPHANT'S TOOTH OBTAINED FROM THE EXCAVATION OF THE DOAB CANAL, IN UPPER INDIA. BY ALEX. CARTE, M.A., M.B., M.R.I.A.

In the November Number of the "Journal of the Geological Society of London," Dr. Falconer, who is, perhaps, the highest authority we have on Indian Palæontology, remarks in the introduction to his paper "On the species of Mastodon and Elephant occurring in the fossil state in Great Britain,"—that "it is of the highest importance to Geology that every mammal found in the fossil state should be defined, as regards, first, its specific distinctness; and second, its range of existence, geographically and in time, with as much exactitude as the available materials and the state of our knowledge at the time will admit. Every form well ascertained becomes a powerful exponent (i. e. to the geologist), while, ill determined, it is a fertile source of error." And again:—"There is a subordination in the value of the (palæontological) evidence: the higher the form in the scale of organization, the more weighty is the import of its indication." In the conclusion of his paper Dr. Falconer observes that "the Mollusca have unquestionably been wielded as a most powerful exponent of geological chronology, and of the successive physical changes which have taken place on the surface of the earth. But it will hardly be denied that the evidence presented by mammalian remains, when obtained in sufficient variety and abundance, is of greater significance as a test of contemporaneous formations in geology, or the reverse." The importance, as will be seen from these quotations, that Dr. Falconer attaches to the evidence afforded by mammalian remains, involving, as a matter of course, investigations in comparative anatomy, has mainly influenced me to enter upon the identification of a fossil tooth, for the exhibition of which this evening the Society is indebted to the kindness of my friend, Mr. Tufnell, who, in a letter to the Rev. Professor Haughton, has given the following particulars:—"I procured the fossil tooth at Kurnaul (among many other remains of deer and different animals), which is situated in Upper India, at about seventy miles from the foot of the Himalayas, and those fossils were obtained in an excavation which Sir Proby Cautley had made through that district, of which it is the most important public work, being well known as the Doab Canal."

Before entering upon the identification of the specimen, it may be advisable to observe that, according to Dr. Falconer, Mastodon and Elephas are Proboscidean genera, so closely allied, as to require for the determination of their several species scarcely any reference to the general character of their comparative osteology, the method of diagnosis which he adopts being solely dependent upon the distinctive characters which the teeth and jaws present. I may further allude to Dr. Falconer's method of subdividing the before-mentioned genera, to the latter of which he attributes three subgenera; namely, first *Stegodon*, comprising the species *Cliftii*, *bombifrons*, *Ganesa* (?), and *insignis*. It is through this subgenus, by its species Cliftii as a link, that Dr. Falconer thinks the genus Elephas remerges into the genus Mastodon. To the second subgenus, *Lox-*

odon, of which the African Elephant is the living type, the species *planifrons*, *meridionalis*, *priscus*, and *Africanus* are allotted; while the third subgenus, termed *Euelephas*, comprises the living Asiatic or true Elephant, the species *Hysudricus*, *antiquus*, *Namadicus*, *Columbi*, *Indicus*, *Armeniacus*, and *primigenius*.

It is to the subgenus Loxodon I would refer the specimen under conderation, and I have little hesitation in identifying it as belonging to the species *planifrons*. The longitudinal axial clefts interruptedly dividing the plates of enamel, their number and circular dilatation in the middle, with their proportional vertical elongation and cuneiform shape, as also the relations existing between the three dental constituents, with the moderate crenulation of the enamelled edges of the plates, indicate, I should say with certainty, the species to which I have referred. Though it is a point of comparatively minor importance, it were to be wished that the definition of the infradental foramina had been less obscure, and had the symphysis which connects this portion of inferior maxillary bone with the left ramus been attached, I should have been better pleased. I may also mention, as an additional means of identification, that the fossa between the coronary and alveolar apophyses corresponds in width to that of the *Loxodon planifrons*, as represented in Cautley and Falconer's beautiful illustrations ("Fauna Antiqua Sivalensis:" London, 1846).

The importance of identification of such specimens as that before us will appear, whether we regard the comparative neglect into which the subject has fallen, or the poverty, I regret to say, of our public collections in this city with respect to remains of this class, not only fossil, but recent; and though I feel that I am unable to direct your attention to anything having the charm of originality, I cannot yet suppose that my endeavours are wholly useless or without interest; in fact, I think every accurate determination, no matter how humble its character, is of scientific value. In point of interest it will be remembered that in the *Loxodon planifrons* we have a starting-point, from which the extremes of a scale of organization radiate, and, as it were, affords a stepping-stone or passage which conducts us directly from the regions of life into the chambers of the ancient dead: on the one hand, namely, from the African Elephant to the *Stegodon insignis*, which, as already mentioned, by the *Steg. Cliftii*, passes into Mastodon proper; and, on the other, through the extinct *Euelephas Hysudricus*, into the Asiatic Elephant and fossil Mammoth.

It is scarcely necessary to remark, that the chief feature by which we are conducted on either side is the comparative elongation or depression of the conical or cuneiform segments of Loxodon into the pyramidical plates of Stegodon as we descend, and into those which display the pectinated or deeply lobed forms of Euelephas in the ascending scale. It is out of place to enter into such details as the numerical increase or diminution, as well as thinness of the ridges in the several graduating species, with other particulars less important as unsuitable to the present purpose, the mere mention of them being sufficient to indicate the extensive nature of the entire subject.

In conclusion, I have only to suggest that it may not be impossible that some such law as is observable in the succession of the Proboscidean organization may ultimately apply in completing the great structural sequence, not only of Mollusca, but of vegetable life, as we find that living Mammalia are frequently intercalated as gradational links between extinct fossil species, as in the case before us of the interposition of the African Elephant between the extinct forms of *planifrons* and *Hysudricus*, or that of the Indian Elephant passing upwards and downwards by *Namadicus* into *Hysudricus*, and again into the extreme of the series *Elephas primigenius*.

The geographical distribution of these fossils will form another subject worthy the attention of future inquirers, and, however invaluable the systematic geological arrangements to which we are at present so much indebted for the regularity and harmony which we experience in our pursuits, it is yet not improbable, and is even to be expected, that as Palæontology, especially that of mammalian remains, advances, modifications will take place as regards our ideas of geological epochs, which will not have the effect of rendering us less grateful for subdivisions of formations by which we have hitherto profited, notwithstanding that they may have been, from the very nature of the case, insufficient for scientific precision.

GENERAL MEETING, WEDNESDAY EVENING, MARCH 10, 1858.

REV. PROFESSOR HAUGHTON, PRESIDENT, in the Chair.

THE Minutes of the last Meeting were read and confirmed. Donations were announced, and thanks voted.

The following gentlemen were elected Members of the Society:—1. J. Birmingham, Esq., Millbrook, Tuam, proposed by J. Beete Jukes, Esq., and seconded by G. Sanders, Esq.; 2. M. Alphonse Gages, Curator of Museum of Irish Industry, Stephen's-green, proposed by J. Beete Jukes, and seconded by G. Sanders, Esq.

DR. E. PERCIVAL WRIGHT read a paper by PROFESSOR KINAHAN—

ON THE ORGANIC RELATIONS OF THE CAMBRIAN ROCKS OF BRAY (COUNTY OF WICKLOW) AND HOWTH (COUNTY OF DUBLIN); WITH NOTICES OF THE MOST REMARKABLE FOSSILS.

IT is necessary to premise that this paper, or at least the subject-matter of it, was read at the recent Meeting of the British Association, and also embodies three communications of mine laid before this Society last year, but not published. I do not now seek to establish any theories, but simply to recapitulate the results to which an examination of the localities of Bray Head and Howth, together with a careful comparison of the remains with recent allied forms, have led. The age of the formation is admitted, I believe, by all, and, therefore, may be assumed as proved.

The two headlands, Bray and Howth, embracing, as it were, between them the Bay of Dublin, differ strikingly in their structure and in the fossils found, both as to amount and kind. A separate notice of each will be necessary.

Howth contains a large mass of Cambrian rocks, chiefly a very fine quartzose grit and slate breccia, with a few regularly schistose beds.

In the locality marked in the maps as Puck's Rocks I was fortunate enough last year to obtain *Oldhamia antiqua*, of which specimens were presented by me to the Museum of Irish Industry. Here also, as well as in the rocks about Candlestick Bay, immense beds of tubuli, similar to those markings called "fucoids," and so common in some Silurian formations, are met with. These have been proved to be tracks of wandering Annelids. What the true nature of both of these appears to be, I will discuss further on.

At Bray the character of the rocks is very constant. Beds of greenish quartzose grit, interstratified with beds of red or grayish-green schist, such as might be deposited in a quiet sea, and occasional masses of pure quartz rocks. In these proofs of organic life of three types at least have been found, viz., Zoophytic, Annellidan, and Molluscan (?).

I.—Zoophytic.

Remains of some zoophytiform animal, probably, judging from its form, Hydroid Sertularian. Two species are distinguishable, and have been named as following. One has been figured in Siluria, but both, up to this, are undescribed.

1.—*Oldhamia antiqua* (*Forbes*).

Polypidom cauliferous; stem percurrent filiform, with short, alternate, fan-shaped branches, arranged at regular intervals.

Occurs in beds, often some inches thick, massed together. There are two varieties of it found in Bray, the one having the fans so crowded as to render it liable to be mistaken for the next species, the other having the fans far apart and distinct. The beds in which this fossil occurs most abundantly at Bray, and all along the coast to Greystones, are greenish schist; it also occurs, but less abundantly, and smaller in size, in red schist. This latter may be a different species, being much smaller, and finer in texture.

The only species which has as yet been detected at Howth. There are striking differences between the specimens from thence and those from Bray. They, however, appear to be identical with specimens from Carrick Mount, county of Wicklow, in the collection of the Geological Survey.

2.—*O. radiata* (*Forbes*).

Polypidoms gregarious (?), short, many-branched; branches irregular, patent, thickened at the end, or many-branched, the branches sometimes arranged regularly in the form of a star.

Occurs in much thicker beds than *O. antiqua*. I am not quite sure whether the form from which the first part of the above description is taken belongs to this or a nondescript species: the more ordinary form has the characters described in the latter part of the description; the

stars in the former measure 1·5 inch in diameter; in the latter 0·5 inch; the stem appears to have been extremely short; in one specimen there appear to have been oviferous capsules.

This is the most abundant species in the Bray beds; bed after bed of it occurring either as single beds, or in series of beds. One of these latter is fully five feet thick; the beds are either red or green schist. I have never met this at Howth, but it occurs abundantly, and very fine, at Greystones, county of Wicklow.

II. Annellidan.

These exhibit themselves as—

1st. Flattened, cylindrical, tortuous markings in the direction of the bedding, or nearly so; their structure ringed so that tearing them across gives the effect of a series of watch-glasses placed one within the other; evidently the exuviæ of worms wandering through beds of muddy sand, and leaving behind them in their course the sand which had contributed its organic elements to their nutriment. They vary in their relation to the bedding, sometimes passing through it almost vertically. They do not present any traces of a tube, and may, therefore, be looked on as the tracks of worms similar in their habits to those which are at present to be found sometimes in myriads in ooze in which much organic matter is present. They occur in the beds in immediate connexion with the Oldhamia at Bray and Greystones, chiefly in the red beds, in immense numbers; more sparingly in the green beds, and also among Oldhamia, but evidently having no special connexion with it. They must have been very active when alive, or else extremely numerous, as the beds are in many places actually knit together by them.

Tubuli of a similar character are also found in Puck's Rocks and other localities at Howth, where, in the weathered rocks, they present an appearance similar to the so-called "*Fucoids.*" These latter may be, and probably are, formed by a distinct species from those at Bray, at least the mounds of *Arenicola piscatorius*, when disturbed, give an appearance very similar to them.

2nd. A series of thread-like tubuli, vertical to the bedding, having slightly trumpet-shaped openings, and arranged in pairs apparently identical with tubuli described as *Arenicola didyma*, in the rocks of the Longmynd, by Salter. These two forms have been figured by me in the volume of the "Natural History Review" for 1857, and also in the "Transactions" of this Society for the same year. They must have been formed in a still estuary. (*Vide* Plate I., Fig. 3.)

3rd. But by far the most remarkable form is that now to be described, and which, as far as I can make out, has not been hitherto known, viz., the tubes of

Histioderma Hibernicum (*mihi*) (ἱστίον, δέρμα) Plate VI., Figs. 1 and 2.

Worm inhabiting a tube and forming a mound. Tubes membranous, from 0·75 inch to 3 inches long, and 0·5 inch in diameter; vertical to bedding; superior extremity of tube trumpet-shaped; inferior turned up, and forming a chamber closed at the extremity.

Head of worm tentacled and branchiated; tentacle casts dichotomous, 1·0 inch, or upwards in length.

These are found in several localities at Bray and Greystones in a close greenish grit; they occur in profusion, and appear to have been in some of their habits, as to burrowing, not dissimilar from the common lug-worm (Arenicola) of our present seas, but the tentacles (?) are arranged similarly to those organs in Sabella or Terebella, to which they are probably allied.

They formed numerous mounds some inches in height, somewhat pyramidal in form, in centre of which was the aperture of the hole.

The beds in which they occur overlie the Oldhamia beds, and are many of them in a fine state of preservation, the ripple-mark, and other characters of the ancient shore in which they formed a prominent feature, being well seen. They were evidently Cephalo-branchiate; the wrinkles of their membranous tubes are easily seen in many specimens (Plate VI., Fig. 1.).

Histioderma Hibernicum has not occurred to me at Howth, and affords one of my reasons for believing the fossils there to be different from those at Bray.

These tubes appear to have been in texture similar to those of Trachyderma (Phillips), to which genus I at first referred them. An examination of the specimens of *Trachyderma coriaceum*, in the collections of the Museum of Practical Geology, Jermyn-street, London, and Museum of Industry, Stephen's-green, Dublin, have led me to believe that the habits of these two worms were very different. I have, therefore, formed a genus of them, named from the membranous texture of their abode. Among the fossils from Carrick Mountain (C. W.) is one which appears to be a portion of one of their tubes; they have also an analogy to the tubes of Aphrodite, one of which is figured, Plate VII., Fig. 4.

The seas in which their mounds were formed must have been moderately still, and left uncovered by the tide for but a short period, as no remains of the rounded excreta of the worms are to be found, as would have been the case had the beach been left for any length uncovered, as we see occurs in the case of *Arenicola piscatorius* of our extreme littoral zone, when compared with the labours of the same animals near high water-mark.

There are other markings in the Bray Head rocks which are probably Annellidan tubuli, lying in the same direction as the bedding; some of them twisted, but all rounded at the ends. These may be the casts of worms of a soft texture, but I have not satisfied myself at all on this point. A fine slab of them may be seen near the first wooden viaduct on the Wicklow line, near Bray, in a scratched rock.

The Annelid tracks reported from Howth as "fucoidal" in their characters resemble much the broken up tubuli made by Arenicola under the last-named circumstances. Fine specimens of all may be seen in the Museum of Industry.

III.—Molluscan (?)

The fossils thus called by me are raised tortuous markings, exactly

similar to those so named in the carboniferous slates. They have been only met at Bray in a thin, green, gritty band, which traversed the red schist at the Ram's Scalp; they may be, and I think probably are, rather Annellidan, especially since amongst them we find peculiar remains similar to "*fucoids*," which here at least, I think, must be looked on as the broken tube casts of a burrowing Annellid. The bed in which they occur is subjacent to a grit bed of rather tough texture, which was evidently formed in a muddy nook of the Cambrian Sea.

Fine specimens of all may be seen in the Museum of Industry.

There are other remains seemingly organic here, but of uncertain nature. Among these I may mention what appears to be the track of an Acalephe, but I am not sufficiently acquainted with the forms of impressions made by these in the recent state to speak positively. *A. chrysaora* makes an impression extremely like that to which I allude; also certain wrinkled markings, possibly the casts of a flat Algal from both Howth and Bray. Time will not permit me to enter more fully into this interesting subject. Nothing remains, then, but to sum up the conclusions at which I have arrived from this examination, which are:—

1st. That at the period of the formation of these rocks the seas (?) in which they were deposited teemed with life of types similar in organization, habits, and conditions of life, with those in post-existent adjacent seas.

2nd. That these were Zoophytes (probably anthozoary) of at least two species; Annellides of several types, highly organized; and probably Mollusca and Acalephæ.

3rd. That, judging from the conditions in which these fossils are found, the animals lived, died, and were deposited in a shallow, quiet sea, and adjacent to some beach which was uncovered at certain intervals.

DESCRIPTION OF PLATES.

Plate VI., Fig. 2.—Head of tube of *Histioderma Hibernicum* (*Kin.*), showing crossing tracks of tentacle casts. Fig. 1.—Cast of middle of tube somewhat compressed, proving membranous nature of tube. Both from Bray Head.

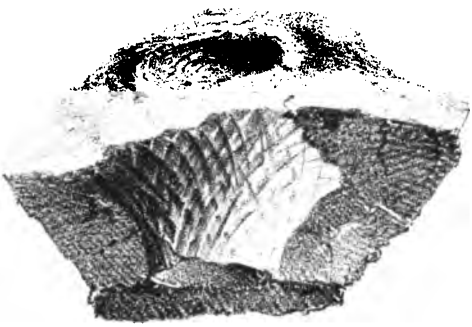
Plate VII. Fig. 2.—Portion of slab from Ram's Skelp, Bray Head, exhibiting tracks. (Molluscan) (?). Fig. 1.—Closely crowded Annelidan tracks, from Puck's Rocks, Howth. Fig. 4.—Section of tube of *Aphrodite aculeata*, dredged at Bray (recent). Fig. 3.—Restoration of *Histioderma Hibernicum*, taken from actual specimen.

Mr. J. Beete Jukes said that, while investigating the rocks in the county of Kildare, near Old Kilcullen, he had discovered an Oldhamia, which had been pronounced as a new species in London; and, on comparing it with the one described by Dr. Kinahan, he was struck by the apparent similarity between the two.

Professor Haughton then left the Chair, which was taken by Mr. J. Beete Jukes.

Fig 1.

Fig 2,



W. Campbell delt. Lith.d at the Office of Dr. Whitty C.E. Du

PLATE VII.

Fig 1.

Fig 2.

Fig 3.

Fig 4

W. Campbell, delt.

Lith^d at the Office of D^r Whitty, C.E. Dublin.

Professor Haughton then read a description, by M. Delesse, of the Granites and Traps of Newry.

Mr. J. Beete Jukes read a letter from Mr. P. Stanley, of Tullamore, addressed to Dr. Apjohn, giving some description of the bogs of that neighbourhood. The writer stated that the substratum of the bogs in that part of the country was generally drift sands and gravels, occasionally intermixed with boulders, clays of a tertiary date being sometimes formed beneath, but always covered by drift. The bogs occur in patches varying in extent from a few perches to several thousand acres, and in depth from a few inches to thirty or forty feet. The shallow bogs consist of one stratum, the deep ones of four strata. The shell marl, sometimes occurring beneath the bogs, consisted chiefly of the remains of shells of a tiny aquatic snail, of a species which, if not extinct, is very scarce in the localities where it was once so plentiful. The snail is found at different levels, varying as much as a hundred feet. Of the four strata of bog, the lowest is of a heavy black kind. In the stratum over this, large stumps of trees are found, oak and yew in the shallower bogs, or nearer the higher lands; fir and alder in the deeper bogs, and over the flattest lands.

The third stratum appears to be composed principally of heath, in some places giving place to black bog, in which iron ore is found abundantly. The fact of this iron ore having been "arrested by animalculæ" is alluded to, and its origin is referred, perhaps, to the iron pyrites existing in the Calp below.

The uppermost stratum of bog was said to be chiefly moss, and to have a considerable thickness, and that additions are being made to it every year.

The Meeting then adjourned to the second Wednesday in April.

GENERAL MEETING, WEDNESDAY, APRIL 14, 1858.

REV. PROFESSOR HAUGHTON in the Chair.

THE Minutes of last Meeting were read and confirmed. Donations announced, and thanks voted.

1. Rev. H. H. Jones, Adare, county of Limerick, being proposed by Mr. J. Beete Jukes, and seconded by Dr. E. Percival Wright, was elected an Annual Member.

Mr. J. BEETE JUKES read the following paper:—

ON A MINERAL FORMING THE CEMENT OF A BOULDER OF CONGLOMERATE, FOUND BY G. H. KINAHAN, ESQ., OF THE GEOLOGICAL SURVEY, NEAR LOUGHHILL, COUNTY OF LIMERICK. BY A. GAGES.

I OWE to the kindness of my friend, G. H. Kinahan, of the Geological Survey, the first specimen of the mineral which forms the subject of the present communication. That specimen, however, was too small to

enable me to make an analysis of it. But other specimens having since been procured by the Geological Survey, from the same locality, I have been enabled to make a more complete investigation of it.

The first specimen given by Mr. Kinahan appears to correspond with the description of Fischerite or Peganite, as given by Dufrenoy and Dana. It is composed of small crystals of an emerald green colour, mingled with some white ones, forming small mammillated concretions, cementing fragments of a quartzose grit.

In the other specimens received, the mineral forms the cement of a conglomerate of a black chert-like stone.

I am informed by the gentlemen of the Geological Survey, that the specimens come from a block found in the drift on the banks of the White River, four miles south of Loughhill, resting on coal-measures; blocks of limestone, trappean breccia, syenite, and granite, occur with it. Wavellite has been found by Messrs. Jukes and Kinahan in the lower beds of the coal-measures, just above the limestone, about three miles north-west of Cahirmoyle.

This mineral exhibits slight pyro-electric properties. I made this observation on a small portion of the mineral carefully separated from the rock. As this mineral begins to lose its water a little above 100 degrees Centigrade, the experiments were made within that range of temperature.

The following are the results of my analysis:—

Water,	23·565
Al_2O_3,	36·160
Fe_2O_3,	1·812
PO_5,	30·881
SiO_2,	3·615
Oxide of Nickel, NiO,	0·325
Apatite, PO_5, $3CaO$,	1·578
Fluorine,	traces.
Quartz,	1·003
	98·939

If we merely take into consideration the phosphoric acid, alumina, and water, the numbers just given would correspond to the formula:—

$$5\left\{\begin{matrix} Al_2O_3 \\ \\ Fe_2O_3 \end{matrix}\right. \quad 3PO_5 + 18\,HO$$

Several minerals have been described from time to time, and classed with Wavellite, whose composition very much resembles the mineral now analyzed. Amongst those may be mentioned the Fischerite of Hermann, for which the formula $2Al_2O_3$, $PO_5 + 8\,HO$, has been proposed, and the Peganite of Breithaupt, which, according to Hermann, has the same composition as Fischerite, but only containing six equivalents of water.

One equivalent of the Irish mineral plus one of alumina, according to the above formula, should be equal to three of Peganite.

The green colour of the mineral analyzed by me is due to oxide of nickel, while that of Breithaupt's Peganite is, according to the analysis of Hermann, due to oxide of copper.

I merely propose the above formula as an expression of a single analysis; but I may observe, that it is quite evident that a great many phosphates of alumina have hitherto been confounded together as Wavellite, and that the complete examination of the whole of this series of minerals would be a desideratum.

I owe also to the kindness of Mr. Kinahan and the Geological Survey, a conglomerate of quartz, cemented by white Wavellite, and found at some distance from the first specimen. It is worthy of observation, that nearly all the varieties of Wavellite are concentrated in this carboniferous locality, and as many of these minerals appear to be of a very recent origin, it may happen that some deposits of phosphatic minerals may exist in the locality.

Dr. E. Percival Wright read the following paper:—

ON THE OCCURRENCE OF A RARE FORM OF POSIDONIA BECHERI IN THE CALP OF RUSH, COUNTY OF DUBLIN, AND OF POSIDONIA LATERALIS IN THE CARBONIFEROUS SLATE OF KINSALE, COUNTY OF CORK. BY SIR RICHARD GRIFFITH, BART., F. G. S.

Palæontologists have hitherto been unable, with any certainty, to decide whether the genus Posidonia, or Posidonomya, should be regarded as a Conchifer, or as the internal plate of an animal allied to Aplysia.

The prevailing opinion, no doubt, tended to the belief that it was a bivalve shell, with affinities approaching to the family Aviculidæ, but as no example of a specimen exhibiting both valves, either closed or open, had been discovered, it was impossible to arrive at any satisfactory conclusion.

A very slight review of what has been written on this subject will be sufficient to show the importance of the present communication.

Professor Phillips ("Pal. Fos.," p. 44), in speaking of the genus Posidonia, says:—"It is remarkable that no case has come under my notice of a specimen in which the opposite valves were in exactly symmetrical apposition." And he further remarks that Bronn, the founder of the genus, gives a drawing ("Lethæa Geognostica," Pl. ii. Fig. 17*b*), which implies that he has seen such a one. But upon referring to Bronn's figure, it would appear to have escaped Mr. Phillips' notice that it is only given as an ideal side view (Ideale seiten ansicht), besides affording an idea of convexity, which we do not find warranted by the fact, making every allowance for compression.

Taking it for granted that the two valves of Posidonia have not been hitherto observed in apposition, I feel gratified in being able to bring forward a certainty in opposition to the ingenious conjecture of M. Deshayes, namely, that the fossils in question were thin, single plates, of the nature of the gill-cover of Aplysia,—a theory to which some probability has been attached by subsequent writers, from the resemblance which, though no doubt considerable, is yet quite insufficient to support

a theory. Through the kindness of Dr. Farran, I have been enabled to compare one of these plates with the fossil; but the former is wholly deficient with respect to the aviculiform sub-auriculation, which is always displayed by the latter; the remaining features, such as the apparent umbo, and irregular concentric wrinkles, teaching us that mere general resemblances are frequently very delusive grounds of assumption, not only in this case, but in any other.

In the progress of my geological examination of the middle limestone, or calp rocks of Rush, near Dublin, at a place called Loughshinny, my attention was attracted to a very clearly-marked *Posidonia Becheri*, which I further found would afford conclusive evidence in reference to the settlement of the point in question. This specimen, which is now before us, and of which a careful drawing has been made* exhibits the casts of both valves of *Posidonia Becheri* attached symmetrically by the oblique hinge characteristic of that genus, their position being exactly that which we have hitherto so much desired to see, and they are each marked by the regular concentric ridges which form an invariable feature in the identification of Posidonia.

The genus has been so long established, and its characters are so commonly known, that it will, of course, be unnecessary to enter upon any formal palæontological details in furtherance of the inquiry before us.

It will in this case be observed that the shell is nearly orbicular, differing in this respect from the obliquely elongated form which it usually presents, but we are aware that the species is subject to considerable variations in outline, as a series of specimens would exhibit gradations from the extreme of obliquity to such remarkably circular forms as the example before us affords.

Amongst numerous other specimens which have been collected at Loughshinny, there is only one in which a faint trace of two valves can be discerned; so that it would appear that the occurrence of such a fossil as that before us is an unusual circumstance.

I may, however, observe that the consideration which has heretofore been chiefly relied on, in justification of the doubt regarding the affinities of Posidonia, namely, the absence of the valves in apposition, has had an importance attached to it which, it appears to me, was not sufficiently borne out by such a circumstance; as any one, even the most cursory observer, cannot fail to have remarked that amongst the numerous variety of shells which lie scattered on most sea-shores, comparatively few are found with both valves attached, either closed or open, and the longer such remains lie exposed to the vicissitudes to which, from various atmospheric and mechanical causes, they are subject, the chances in favour of ligamentary attachment will be continually lessening. Of course I am aware that the force of a consideration apparently so simple is very much increased by the light which such a discovery as that before us affords; very simple circumstances, from which correct inferences might be drawn, being often overlooked in the absence of tangible

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* See Plate XVIII., Fig. 1.

facts. A similar remark applies to fossil bivalves generally, as in comparatively few instances do we find both valves attached, while the occurrence of single valves is most commonly to be observed.

As an exemplification, I might select the case of the genus Aviculopecten, which in its numerous species rarely presents to our view more than a single valve, though (as has been completely overlooked in the case of Posidonia) the right and left valve of the same species unattached are frequently found to occur, thus enabling us to arrive at as certain a conclusion (and in both cases equally) as if we were in possession of the accidental fact of apposition.

In addition to the collection which I have made, the President has enabled me to exhibit specimens obtained by him from the same locality, in one of which a portion of the shell itself has been preserved, and, notwithstanding its thinness, it does not exactly justify the anticipation we might have formed relative to its membraneous or extremely fragile character, its thickness being not inaptly compared to that of an egg-shell; and when we remember that these fossils are, for the most part, mere impressions, the fact of the ridges of different individuals crossing each other in various directions will occasion no surprise; nor can we necessarily conclude that the shell was flexible on that account: on the contrary, we are now aware that it was of a firm and brittle texture.

The President has also kindly favoured me with another specimen which, though it would have been insufficient without the aid of my more perfect fossil to determine the inquiry satisfactorily, is yet very valuable, as affording a repetition of the fact we are considering; and I am happy to find that Dr. Carte, whose attention has been directed to the subject, has lately succeeded in procuring a third* example in which the bivalve structure can be clearly traced; and though, in common with many other lamellibranchiate fossils, the closed valves in apposition have not been hitherto observed, yet I should say that a positive statement as to the non-existence of such a case would be a very unsafe position, as we are not in a condition to say that the opposite valve may not be present in many cases, though concealed in the adhesive matrix of surrounding shale.

Little need be said further as to the shell itself, except that it were to be wished that some more satisfactory mode of defining the present species (if not of the whole genus) existed, as one sometimes feels a difficulty in ascribing identity, or the contrary, to such varied forms as frequently present themselves; and it may be worth our notice how far some of the species at least, which at present are regarded as belonging to the genus Inoceramus, may not rather form a portion of the genus Posidonia, a consideration probably of some importance with respect to the geological bearings of the subject.

In the strata alternating with the fine-grained dark shales which contain Posidonia, as well as in those latter, we find the carboniferous fossils, *Fenestella, Productus concinnus, Goniatites reticulatus* and *spi-*

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* Mr. Hargrave, one of Mr. Haughton's pupils, has recently obtained another specimen, showing both valves, from the neighbourhood of Rush. See Plate XVIII., Fig. 2.

ralis, the last-mentioned (which has been frequently supposed to be an Orbicula) being obtained perhaps in a better state of preservation and of a larger size in the shales of Rush than in those of any other locality in Ireland. Vegetable remains are also of frequent occurrence in the Goniatite beds, and these remains are undoubtedly identical with those occurring at the Naul and Clontarf, which have been described and figured in a former Number of our Journal by my friend Professor Haughton. *Posidonia membranacea* is likewise very abundant in this locality, but it is difficult to procure a good cabinet specimen of the fossil, owing to the rapid decomposition to which the external surface of the shale is liable; and Dr. Carte has recently succeeded in procuring a specimen of *Posidonia lateralis* in the same strata which contain the fossil under our consideration.

As to the geological bearing of the question, it may be observed that the Calp, or middle limestone rocks of Ireland, in the shales of which Posidoniæ occur so abundantly, are interposed between two blue subcrystalline limestones, to which I have applied the relative terms Upper and Lower, one of them (or, perhaps, to a certain extent both) being the equivalent of the mountain limestone of England. These Calp strata consist of impure siliceo-argillaceous limestone, interstratified with shales of various degrees of hardness, which frequently contain layers of chert, and it is in the shales and impure shaly limestones of finest grain that we find the matrices of the Posidoniæ, as appears from the specimens now before us.

There are, besides, occasionally interstratified with the shales at Rush, remarkable fossiliferous conglomerates, the pebbles of which vary from a size nearly half a foot in diameter to very small angular and rounded fragments of slate, limestone, and quartz, which are probably of Silurian age; and we have likewise other conglomerates, containing very numerous pebbles, which may possibly be regarded as carboniferous limestone, the appearance which they present being exactly similar to such recent breaches of shingle as may be observed at several points on the same shore. Blue fossiliferous limestone, containing *Naticopsis Phillipsii*, &c., occurs as we approach the town of Skerries; and I may remark that my friend Professor Jukes, who has minutely examined this interesting locality, is of opinion that it is difficult to determine the position of this limestone in the series, owing to the disturbance of the strata, as, for all we can say, it may represent either the upper or the lower limestone, and may possibly include both.

The Calp series, which is always of a dark gray colour, becomes occasionally separable into an upper and a lower portion, as in the north of Ireland, by means of a considerable thickness of intervening hard, compact, yellowish gray sandstone, an incipient representative of which may be observed in the Knockmaroon district of the county of Dublin. It may be useful to supply a few of the localities in Ireland in which the Posidoniæ have been found to occur most abundantly in the calp series. They have been principally obtained in the shales near Nobber, at Cruicetown, and near Navan, at Walterstown, in the county of Meath, also near Balbriggan, at Courtlough, and near Skerries, at Baldongan,

as well as near Rush, at Loughshinny, already mentioned, in the county of Dublin; but no doubt they occur in the fine-grained dark gray shales in many other localities, as I am informed by Mr. Jukes that they have been collected in the neighbourhood of Garristown, also in the county of Dublin.

It would exceed the design of the present communication to enter into further details with reference to the remarkable geological features which can be studied with so much advantage in the vicinity of Rush, especially as we may expect that the President, as well as Mr. Jukes, will favour us with their views; but I may observe that probably there will be found in few places, within a small compass, such a variety of interesting examples of study as we have presented on this shore, the convoluted strata of which form, in fact, a natural model, as it were, of abstract Geology.

Immediately above the upper carboniferous limestone, and conformable with it, lie beds of the millstone grit series, or, as in reference to Ireland they might be called, the marine coal formation, from the occurrence of marine fossils in abundance, which are characteristic of the carboniferous limestone series generally. These fossils consist of Zoophytes, Crustacea, Brachiopoda, Conchifera, Gasteropoda, and Cephalopoda. This series in Ireland is divisible into an upper and lower sandstone or grit (in which are frequently found casts of Lepidodendra and Stigmariæ), having a considerable thickness of fine-grained, dark gray shale interposed, in which latter numerous beds of argillaceous ironstone are intercalated; and it is these shales which contain such a numerous variety of marine fossils of the ordinary carboniferous type, as I have mentioned above, the *Aviculo-pecten papyraceus* characteristic of the formation, as in England, being abundant throughout. As in the case of those of the Calp series, so in the finer-grained shales of this formation, casts of Posidonia in great profusion are found to occur, and the several varieties of form in both cases are identical, such as *Becheri*, *lateralis*, and *tuberculata*, though some of those of the smaller sort may possibly be new, and others would appear to be of the genus Inoceramus. Ferns, *Sigillariæ* and *Lepidodendra*, are also abundant, and we occasionally meet with interstratifications of flaggy fossiliferous limestone. The localities in which Posidoniæ most abound are near Ennistymon, in the county of Clare; Ballybunnion, in the county of Kerry; Braulieve Mountains, in the county of Sligo; Cuilcagh Mountain and the Alteen River, in the county of Cavan; Corry,* near Drumkeeran, in the county of Leitrim; and Mullaun and Carrownanalt, near Keadue, with the Munterkenny Mountains, in the county of Roscommon.

Before closing this communication, I should wish to mention that in making researches relative to the persistence of the genus Posidonia, I have ascertained its occurrence at the base of the carboniferous series in the suite of rocks to which I have given the name "carboniferous slate," in the Geological Map of Ireland; and I think it may be desirable to make some reference to this fact, as well as to give a short description

* See Plate XVIII., Fig. 3.

of the strata of this lower series. These rocks (typical in the south of Ireland) consist of cleavable slates or shales, the colour of which varies from dark gray to greenish or yellowish gray,—the former, however, being the predominating tint. The shale beds are usually interstratified with compact sandstone, and occasionally with limestone, the latter being sometimes of considerable thickness; the whole lying conformably beneath the lower limestone, and similarly resting on the sandstone, for which I have hitherto adopted the term "yellow sandstone," to distinguish it from the subjacent and conformable beds of the true, and probably non-fossiliferous, Old Red Sandstone. Both these subdivisions—namely, the carboniferous slate and yellow sandstone—are so immediately connected, and pass so insensibly into each other, stratigraphically as well as by fossils, that I have classified them on the map as one series, under the term "yellow sandstone group."

It is in the carboniferous slate or shale, the upper member of this group, at Lispatrick and other localities of the same district, near the Old Head of Kinsale, in the county of Cork, that the impressions of Posidoniæ occur, to which I have referred; and they are accompanied by numerous other ordinary carboniferous fossils, especially by the *Goniatites striolatus*, the surface of which is ornamentally pyritised; and I may in addition enumerate *Orthis crenistria, Spirifer attenuatus, Turbinolia fungites*, &c. There is much difficulty in this locality in procuring specimens in a sufficiently perfect state for identification, the portions of the impression most necessary for that purpose being generally imperfect, owing to the scaling and crumbling nature of the shale, as well as to the distortion produced by the action of cleavage on the one hand, and, on the other, by those portions remaining hidden in the rock being cut off by innumerable cross or dip joints, which are frequently less than half an inch asunder; and in this respect they are quite similar to those which occur in the Calp of Rush. The *Posidonia lateralis** now before us, as represented in the diagrams I have prepared, will be seen to have been much extended in the direction of the longer axis of the shell by the action of cleavage, but I think the distortion will yet hardly amount to such a degree as to render the specimens incapable of identification with those usually figured as *P. lateralis*. The impression,† as represented in the diagram beneath the former, may possibly be the same species, the extension being parallel to the direction of the shorter diameter of the shell; but I shall leave the consideration of this subject in the hands of the Reverend President, who is so much better qualified than I am to discuss its bearings, not only from the attention which he has already directed to it, but from the researches in which he is at the present moment engaged, and from which we may expect in future such valuable results.‡

* See Plates XVI., XVII. † See Plate XIX., Fig. 2.

‡ *Note added in the Press.*—Subsequently to the printing of my paper, the President has kindly undertaken to add a note in reference to the effect which cleavage produces in the distortion of fossil forms. The note alluded to is printed in full, page 161. Mr. Haughton has also given a review of the genus, which, it is to be hoped, will tend to simplify its specific diagnosis.—R. G.

Immediately accompanying the *Posidonia lateralis*, in the same bed, I have discovered a very beautiful and remarkable *Avicula*,* which is represented by the lower figure in one of the diagrams; and as I do not remember to have seen it before, it may probably be new, but it is at least very valuable from the unusually perfect state in which it is preserved,—a circumstance which is very rare in cleavable rocks, as may be observed from the great variety of forms of distortion afforded by the Posidoniæ of Kinsale.

I have thus shown that Posidoniæ occur in the fine-grained, dark-coloured shales throughout the entire range of the carboniferous series in Ireland, from the base of the marine coal formation to the upper portion of the yellow sandstone group of strata; and it is remarkable that in both cases they are accompanied by the fossil, *Goniatites striolatus*. It only remains to remark, in conclusion, that notwithstanding the prevalence of these fossils in certain groups of strata, they would rather seem to afford an indication of mineral conditions and of mechanical depositions than be of rigid application in the determination of geological subdivisions, as it appears that their presence is dependent upon the predominance of argillaceous rather than of calcareous or siliceous matter in the bottoms in which they are found; but, however this may be, we can safely affirm that they are eminently characteristic of the carboniferous series; and it is satisfactory to be able to prove that these remains were true lamellibranchiate bivalves, as given in the Table of Fossils appended to my Geological Map of Ireland.

NOTE ON THE ALTERATION IN THE FORM OF POSIDONIA PRODUCED BY CLEAVAGE AND THE PRESSURE OF THE SURROUNDING MATRIX. BY THE PRESIDENT.

I HAVE carefully examined the form of *Posidonia Becheri* from the elliptical rings, in specimens in the Museum of Trinity College, brought from Herborn in Nassau. The ratio of axes of the adult shell is 1·38.

The specimen, Plate XVIII., Fig. 3, from Corry, Drumkeeran, has a ratio of 1·40, and is identical with the *P. Becheri* of the Germans.

Plate XVIII., Fig. 2, represents a variety, with broad, deep annulations, found in the harder beds of impure shaly limestone at Rush, county of Dublin.

Plate XVIII., Fig. 1, represents a nearly circular variety.

The specimens figured in Plates XVI., XVII., and XIX., are from the highly cleaved Carboniferous Slate of Kinsale Head. I believe them to be all *P. Becheri*.

In the type shell, unfortunately, the elliptical lines of growth are oblique to the hinge-line, which is very indefinitely marked, and in consequence it is difficult to say, in the case of the distorted fossils, what the original position of the hinge and elliptical lines may have been. I have,

* This fossil has been unfortunately mislaid in London, so that, being unable to figure it sufficiently accurately, I prefer to omit it in the Plates.—R. G.

therefore, found it impossible to calculate numerically the amount of distortion, as the original position of the shell is unknown, and it was not circular. There is, however, a general agreement with the laws of distortion of fossils, as laid down by me in the "Phil. Mag." vol. xii., 1856. This is shown by the following series of numbers, which express the ratio of axes and angle between cleavage and bedding in the several cases.

It is to be observed that the major axes of the distorted elliptical rings are always parallel to the intersection of cleavage and bedding, whatever may have been the position of the rings originally.

Ratio of axes.	Angle between cleavage and bedding.	Plate.	Fig.
2·11	22°	XIX.	2.
1·96	42°	XIX.	1.
2.58	53°	XIX.	3.
3·03	57°	XVI.	2.
3·45	56°	XVII.	1.
3·75	unknown	XVI.	1.
4·44	62°	XVII.	2.

It appears from the preceding that, with some exceptions, which could be explained, probably, if the original position of the shell were known, the ratio of axes of the shell increases with the angle between cleavage and bedding; and that all the shells are probably of one species, as the variations of form are attributable to the distortion produced by cleavage.

DESCRIPTION OF PLATES XVI., XVII., XVIII., XIX.

PLATE XVI.

Figs. 1, 2. Valves of *Posidonia Becheri* distorted by cleavage, as shown in the drawn-out condition of the rings of growth.

If m and n denote the axes parallel and perpendicular to the intersection of cleavage and bedding; and ϕ the angle between these planes—

Fig. 1. $$\frac{m}{n} = 3{\cdot}75.$$

Fig. 2. $$\frac{m}{n} = 3{\cdot}03, \quad \phi = 57^\circ.$$

Locality: Old Head of Kinsale, county of Cork.

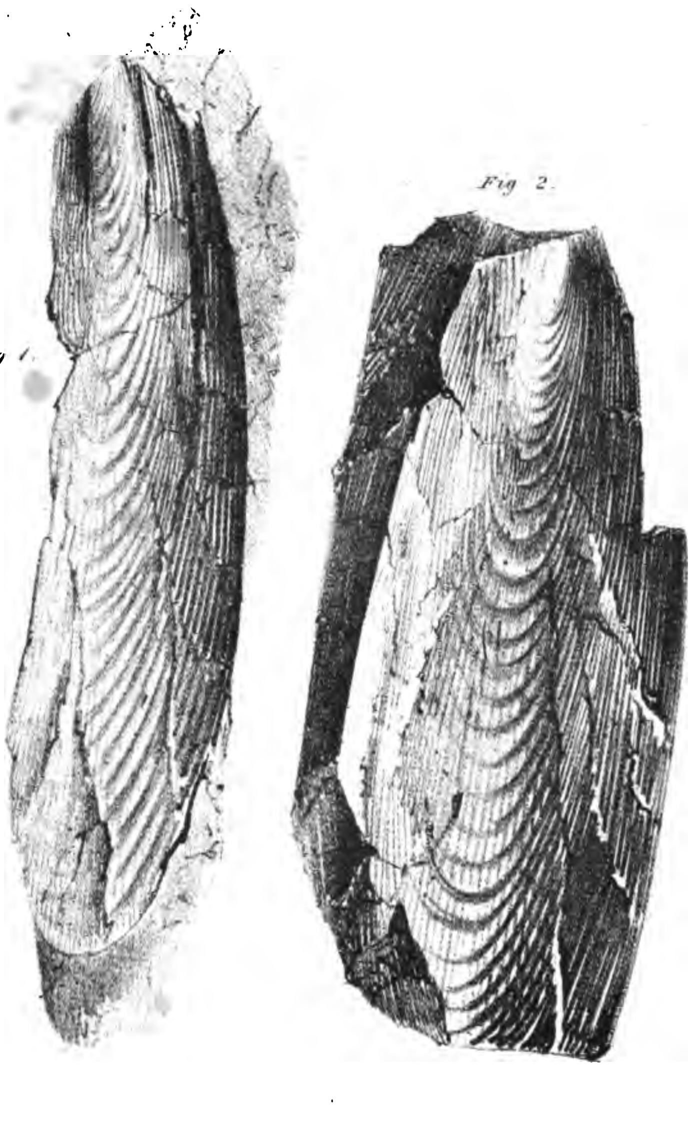
PLATE XVII.

Fig. 1. Similar to last—

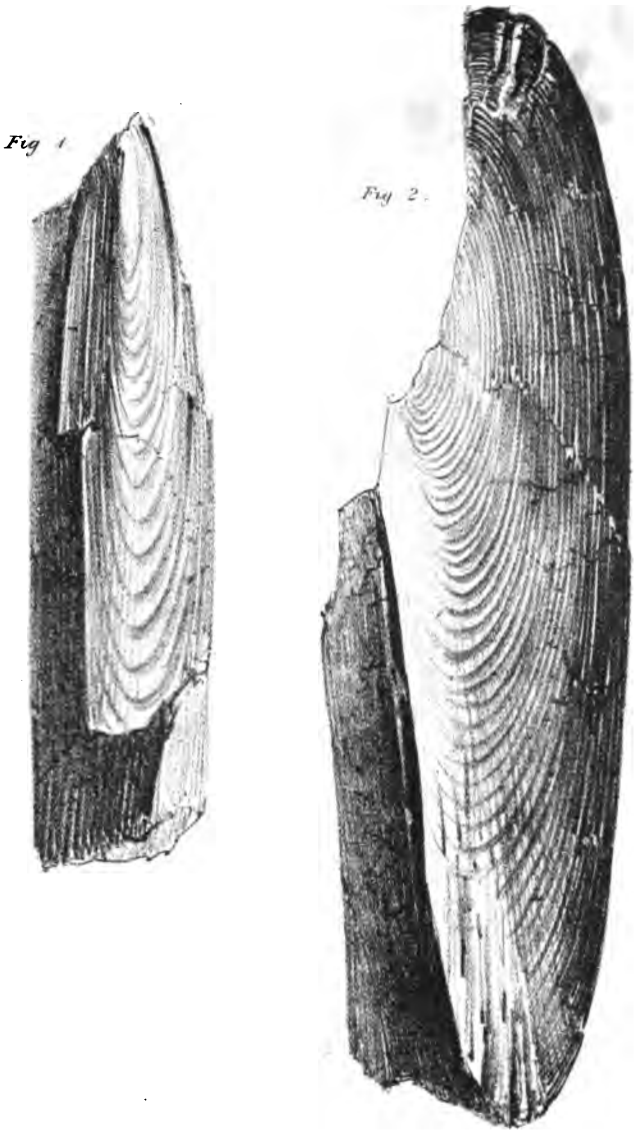
$$\frac{m}{n} = 3{\cdot}45, \quad \phi = 56^\circ.$$

Fig. 2. This specimen has undergone more distortion than any of the others, and is, therefore, more likely to be magnified by the species-maker into a new variety. I believe it to be simply *P. Becheri*, after a very severe stretch—

GEOL: SOC: DUBLIN. PLATE XVI.



W. Campbell. delt. Lith.d at the Office of Dr Whitty. C. E. Dublin.

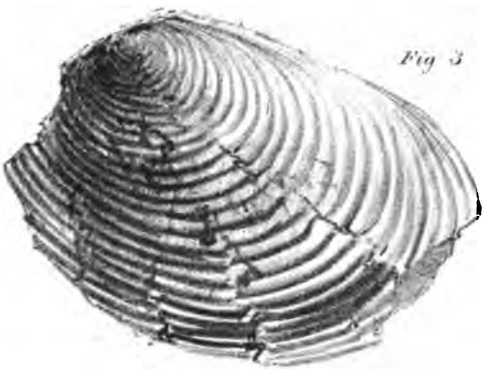


W. Campbell delt. Lith.d at the Office of Dr Whitty. C.E. Dublin.

Fig 1.

Fig 2.

Fig 3



W. Campbell delt. Lith. at the Office of Dr. Whitty; C.E. Dublin

Fig 1

Fig 2

Fig 3

W. Campbell delt.

Lith at the Office of Dr Whitty C.E. Dublin

$$\frac{m}{n} = 4{\cdot}44, \quad \phi = 62^\circ.$$

Locality : Old Head of Kinsale, county of Cork.

PLATE XVIII.

Fig. 1. *P. Becheri*, almost circular variety, showing both valves. The beds at Rush in which it is found are much distorted, but show no signs of true cleavage—

$$\frac{m}{n} = 1{\cdot}09.$$

Locality : Loughshinny, county of Dublin.

Fig. 2. *P. Becheri*, with broad, deep annulations; showing both valves; cut off abruptly by one of the joint surfaces which are common in the distorted shale of Loughshinny, Rush, county of Dublin, where these fossils are found in abundance in the black shale beds between beds of crinoid and spirifer limestones.

Locality : Loughshinny, county of Dublin.

Fig. 3. Typical specimen of *P. Becheri* from Corry, Drumkeeran, county of Leitrim, where it is found in blue shale, resembling the dark mud beds of Rush and Kinsale—

$$\frac{m}{n} = 1{\cdot}40.$$

Locality : Corry, Drumkeeran, county of Leitrim.

P. Becheri.—Testâ obliquâ ellipticâ, vix concameratâ; costis multis, bene figuratis, culminatis, concentricis; umbone parvulo vix eminente, in medio cardinis recti posito.

Professor Bronn considers Posidonia to belong to the Aviculaceæ, and to be intimately allied to Inoceramus. He unites with *P. Becheri* both *P. lateralis* and *P. tuberculata*, figured in Sedgwick's Account of the Geology of Devonshire.—Trans. Geol. Soc. London, second series, vol. v. Plate LII.

In this union of species I fully concur, and think it would be highly interesting to know whether the specimens figured by Sedgwick were found in cleaved beds or not.

The generic character is thus given by Bronn :—

Posidonia :—Shell equivalved, unequal; oblique oval, or roundish; very thin; both externally and internally concentrically wrinkled; the hinge-line straight, long, forming an angle with the rim of the shell, both before and behind the scarcely prominent beaks.

PLATE XIX.

Figs. 1, 2, 3.—Specimens of *P. Becheri*, variously distorted by cleavage.

Fig. 1. $\frac{m}{n} = 1{\cdot}96, \quad \phi = 42^\circ.$

Fig. 2. $\frac{m}{n} = 2{\cdot}58, \quad \phi = 53°.$

Fig. 3. $\frac{m}{n} = 2{\cdot}11, \quad \phi = 22°.$

Locality: Old Head of Kinsale, county of Cork.

Dr. E. Percival Wright opposed the idea that Posidonia was an Entomostracan shell, or that it was at all allied to Aplysia; on the contrary, he believed it to have been a molluscous animal, whose affinities approached very near to those of Avicula; and he thought that the specimen exhibited by Sir R. Griffith completely settled the question.

Professor Haughton believed that the strata between Rush and the Skerries could not be more than 200 feet thick, and that the mud strata in which Posidonia and the Goniatites occur were identical. These mud bands occurred between strata of crinoid limestone, in which Fenestellæ are found. He thought that these mud bands were of fluviatile origin, their dark colour being due to the presence of plants, the conglomerate accompanying them indicating a sea shore. The various species of Posidonia might be, perhaps, referred to one, when the distortion due to cleavage was taken into account.

Mr. J. Beete Jukes fully concurred with Sir Richard Griffith as to the great rarity of finding both valves of Molluscan shells, even in a recent state; he had not been able accurately to refer the Conglomerate of Rush to either the upper or lower limestone series.

Lord Talbot de Malahide then took the Chair.

The President read a paper—

ON REVERSED FAULTS OCCURRING IN ANTICLINAL FOLDS WITH OBLIQUE AXES, ILLUSTRATED BY A CASE AT LOUGHSHINNY, COUNTY OF DUBLIN.

Having recently had occasion to study somewhat carefully the conditions under which reversed faults occur, and having arrived at some results, which, so far as I know, have not been published hitherto, I thought it might be useful to lay them before the Society, in the hope that the circumstances under which reversed faults occur may be noted occasionally, and thus more facts collected, on which to construct a complete theory of the forces which have given rise to them.

It is well known to engineers that if a bank of earth be retained by a vertical revetment wall, there is a certain plane, which may be called the *natural plane of slipping*, along with there is the greatest tendency of the bank to slide. If u denote the underlay (or angle with the vertical) of this plane, and ϕ the angle of friction between the masses of which the bank is composed; then—

$$u = 45° - \frac{\phi}{2}. \qquad (1)$$

If, from any cause, the bank of earth should tend to slip down some other plane, not the *natural plane of slipping*, then the horizontal force necessary to keep it from so slipping is,

$$P = \tfrac{1}{2}\mu x^2 \tan u \cot (u + \phi); \tag{2}$$

where μ denotes the weight of a cube foot of the bank, x the height of the revetment wall, and P the force per linear foot of breadth requisite to keep the bank from slipping.

If this engineering problem be inverted, and a geological one substituted for it, viz., to find the horizontal force necessary to produce fracture in a mass of rock or gravel, it is not difficult to infer the following results :—

I. If a horizontal thrust be applied to a bank of rock (Plate XX., Fig. 1), there is a certain plane oa, along which the fracture of the rock mass is easiest, which I shall call the "*Natural Plane of Fracture,*" determined by the equation—

$$u = 45^\circ + \frac{\phi}{2}. \tag{3}$$

II. There is a certain other plane ob, which I shall call the "*Plane of impossible Fracture,*" up which it would require an infinite force to push the rock mass. This plane is determined by the condition—

$$u = \phi. \tag{4}$$

III. If, from any cause, the fracture of the rock mass take place along some other plane ox, the force requisite to push the mass up the plane is determined by the condition—

$$P = \tfrac{1}{2}\mu x^2 \tan u \cot (u - \phi). \tag{5}$$

The second case is illustrated in Plate XX., Fig. 2, which represents the reaction of the plane of impossible fracture as horizontal, because $\phi = u$, and therefore it would require an infinite force to push the weight up the plane.

In Fig. 3 I have illustrated a remarkable case of oblique anticlinal axis, occurring at Loughshinny, county of Dublin, with fracture along the inclined line of overturned beds xy, and a slight reversed fault along the plane of fracture. The figure is accurately drawn with respect to the inclination of the beds and of the fault.

The bed $a'b'$ is a bed of crystalline crinoid limestone, and is the first which has undergone fracture. Its inclinations are 25° and 55° at each side of the axis, and the underlay of the fracture xy is 50°.

The planes oa and ob are the "planes of natural fracture and of impossible fracture," and their underlay, as found from equations (3) and (4) are—

$$oa = 62^\circ\ 30',$$
$$ob = 35^\circ;$$

assuming ϕ to be 35°, which cannot be far from the truth.

The actual plane of fracture xy is intermediate between these two planes, and is occasioned by the plane of weakness caused by the bending over of the contorted strata.

Equations (2) and (5) give the forces requisite to keep from slipping down and to push up a mass of rock along any given plane ox; and since the weight of the mass kept from slipping down or pushed up is—

$$W = \tfrac{1}{2}\mu x^2 \tan u; \tag{6}$$

by substitution these equations become—

$$P = W \cot (u + \phi), \tag{7}$$

$$P = W \cot (u - \phi). \tag{8}$$

As the rock mass in this case has been slightly pushed up the slope xy, we are to use equation (8) to find the horizontal force requisite to produce this *reversed* fault—

$$P = 3{\cdot}73 \times W.$$

It therefore required a horizontal force little less than four times the weight of the rock mass to cause the reversed fault.

If we wish to know the force requisite to prevent a *direct* fault, we must use equation (7)—

$$P = 0{\cdot}087 \times W.$$

If the horizontal force be less than about one-twelfth of the weight, and the line of fault already established, a *direct* fault or slip would occur.

Such a force as this could never cause the overturning of the beds, or produce a reversed fault; and this latter kind of fault may occur whenever fractures of overturned oblique anticlinal and synclinal axes take place along the bend of the curves of strata.

The Meeting then adjourned to the second Wednesday in May.

GENERAL MEETING, MAY 12, 1858.

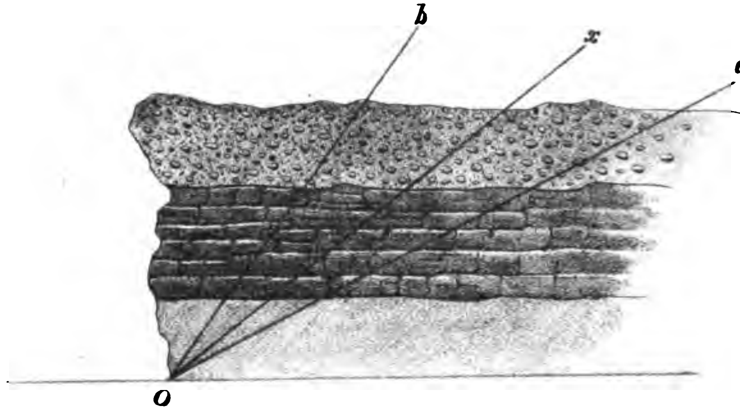
The President in the Chair.

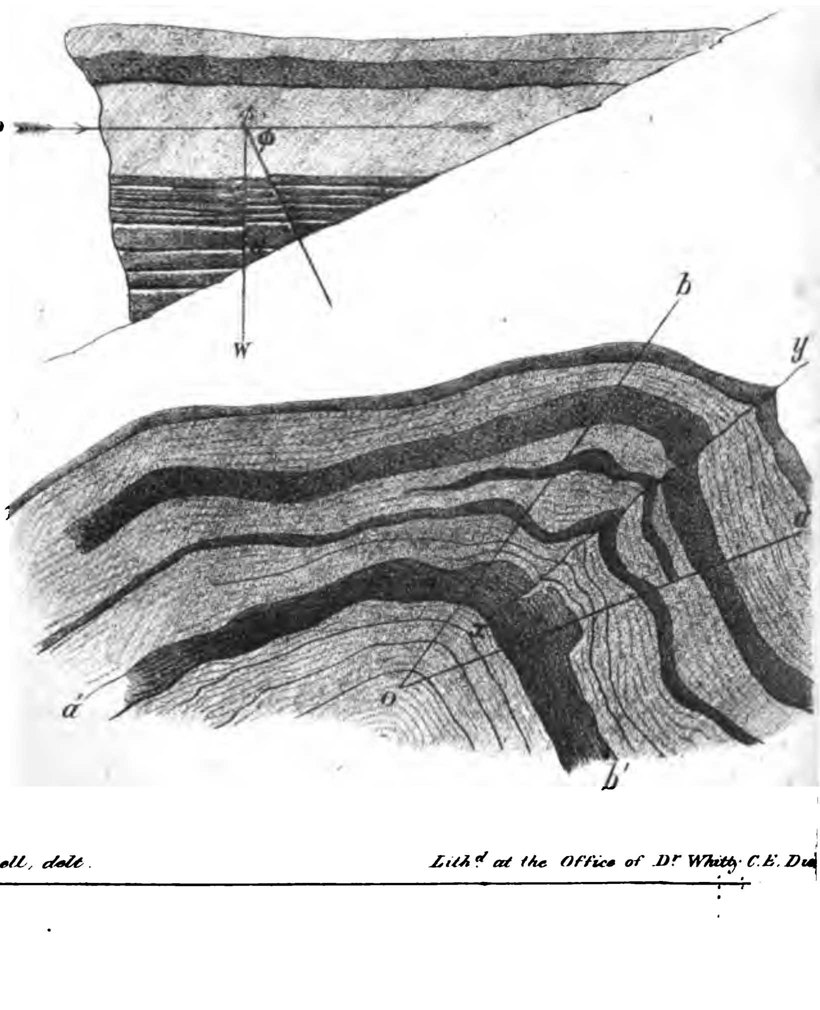
The President exhibited, on the part of George M'Dowell, Esq., an ornament partly composed of aluminum.

The President then read his paper on the occurrence of Gray Copper in the Yellow Sandstone near Boyle, county of Roscommon. The copper occurs in red slate, at a depth of about 2640 feet below the base of the Carboniferous Limestone.

The President pointed out the analogy between this occurrence and that of copper in the south of Ireland, in similar beds, and that in each case the copper ore was either gray copper or blue copper, and never ~rites.

GEOL: SOC: DUB: PLATE XX.





W. Campbell, delt. Lithd at the Office of Dr Whitty C.E. Du

Mr. J. Beete Jukes remarked on the singularity of the diffusion of copper in particular beds in the south-west of Ireland, and in the same beds in the north; and pointed out that light might possibly be thrown on the question of the deposit of ores in mineral veins by any one who would observe the relations between the ore in the beds and that in the lodes at Coosheen and elsewhere.

The President then read his paper on the occurrence of some new and rare forms of Annellidoid tracks in the coal-measures of Lugacurren, Queen's County. He illustrated his paper by rough drawings, separating them into two sets, of which he believed one to be a molluscan track, and another with a curious punctured impression in the centre passing into linear marks.

Dr. Kinahan made some remarks, in which he stated his belief that all the tracks were molluscan, basing his argument partly on the sharpness of the turns, mollusca turning much more rapidly than worms could.

Mr. Mallett and Mr. Jukes made some observations; the latter calling attention to some enormous tracks in coal-measure flagstones, to be seen in the Museum of the Geological Society of Manchester.

Mr. J. B. Doyle then exhibited some fine examples of fossil corals from Devonshire. These consisted of polished specimens from Newtown Abbot and other places.

Dr. J. R. Kinahan exhibited a series of fossils from the marine drift of Bohernabreena, county of Dublin. These consisted of angular, slightly rolled fragments of *Cyprina islandica*, *Tellina solida*, *Mactra solida*, *Ostrea edulis*, *Pholas* ——? *Venus striata* and *casina*, and of a valve of Balanus unrolled, and unrolled specimens of *Nucula tenuis* and *Turritella communis*. He described the portion of the drift in which they occurred as being made up of coarse, angular, scarcely rolled fragments, cemented together with carbonate of lime. The drift in which the shells occurred lies on the corn gravel, and preserves everywhere the same character, of having mixed up in it a large proportion of but slightly rolled pebbles, being very distinct from the ordinary gravel of the neighbourhood, which is nearly entirely made up of rolled and rounded pebbles, and apparently, in a great measure, the results of the wearing down and breaking up of the gravel by the action of water. The whole appearances would suggest the idea that the gravel in which the shells occurred had been subjected to the action of a violent surf, which had broken up the deep sea-shells, such as *Cyprina islandica*, and tossed them up unrolled, with specimens of the more immediate inhabitants of the littoral. This would account for the hinge teeth and striæ of such shells as *Nucula* and *Venus striata*, and *casina*, being preserved comparatively uninjured, and for the fine condition of the valve of the Balanus exhibited. In the course of the Paper occasion was taken to advert to the importance in drift deposits of remarking the conditions and characters of the fossils; and it stated that fossil shells, in the more recent deposits, were easily divided into *shells in situ*, where the animals had lived and died in the deposits, and the shells were thence generally found perfect; and *trans-*

ported shells. That these latter might be either shells of inhabitants of deeper zones, on which the action of the sea had been but brief (such as a surf), as in the present instance, the striæ, &c., of the shells in this case being preserved, although the shells were generally broken and mixed with unbroken shells of littoral molluscs, &c.; or they might be shells which had been subjected to the frequent action of the water, as on a sandy beach or gravel shingle, where the force of the water was comparatively small, but long continued, and the shells in consequence polished, and all the striæ worn off; the pebbles in which they occur, in this case, being mostly rounded, with but few angular fragments among them. A third set of transported shells were those which, having been once buried in the drift, and then elevated, were afterwards unburied by the wearing away of those beds in which they lay, and then reburied in the more modern beach. These shells were invariably rubbed, and also generally much corroded. General remarks on the various modes in which beaches were formed, and the evidences of the mode of their formation, concluded the paper. The shells had only occurred in two localities—one immediately above Bohernabreena. This was pointed out some years since by Professor Scouler. The second, about half a mile lower down the river, in the old Fox-earths, on the opposite side of the river.

The President and Mr. Mallett made observations on the paper. Mr. Mallett pointed to the Escar of the Green Hills as an old tidal bar of the Dodder Valley, and alluded to the scratchings and the present position of the drift, as formed by subsequent slippages.

Dr. Kinahan applied and accepted Mr. Mallett's explanation of the bar origin of the Escars as explaining also the absence of shells in them.

The Meeting then adjourned to the second Wednesday in June.

GENERAL MEETING, WEDNESDAY EVENING, JUNE 9, 1858.

The President in the Chair.

Professor Kinahan read a paper on the Raised Sea Beaches of Port Philip, Victoria, observed by him in the year 1855. He stated that the great portion of coast consists of raised sand-hills, containing shells, and broken in two or three places by projecting rock; that these sand-hills are frequently backed by a lagoon or arm of the sea, gradually separated from it, and in some instances communicating with it at high tide. In some places sections of these sand-hills are made by the sea; from which Professor Kinahan drew the conclusion that the whole beach had been subject to three periods of submergence and elevation.

William H. Baily, F. G. S., read the following paper—

ON A CRUSTACEAN FROM THE COAL-MEASURES, WITH SOME REMARKS ON THE GENUS LIMULUS.

The fragment of shale on which these interesting remains of Crustacea are impressed was collected by George Henry Kinahan, Esq., of the Geological Survey, in the Bilboa Colliery, county of Carlow, from the three-foot bed of black shale immediately over the coal, associated with plants, and small fresh-water bivalves allied to Unio.

The specimen exhibits the upper surfaces of three detached cephalic shields, evidently belonging to one species, and presenting generic characters similar to those peculiar forms of Crustacea found in ironstone nodules of the lower coal-measures at Coalbrookdale, Shropshire. Although the only parts of this species, yet discovered, are the separated heads or cephalic shields, their generic identity with those from Coalbrookdale is easily recognised, and the specimens, so far, are sufficiently well preserved for description.

Before doing so, however, I would offer a few remarks on the genus Limulus, in which all these coal-measure Crustacea have been hitherto included, and which I now propose, from their greater affinity with the Trilobites, to remove, and constitute a new genus under the name of Steropis, for the following reasons. In the first place, their general form and size bear a much stronger resemblance to several of the Trilobites than they do to the recent Limulus, from which it differs in possessing (although not so perfect as in the Trilobites) a more distinct trilobation, with the abdomen separated into segments. The abdominal or caudal shield corresponds almost completely in point of size and form with that of Amphyx, Trinucleus, &c.; and the characteristic spiny termination of the pleuræ to that of Acidaspis and Paradoxides. The possession of legs and articulation of the caudal spine, which they are said to be provided with, would connect them with the Jurassic and recent Limulus; although there is a striking analogy to the latter case presented by some of the Silurian Trilobites, as *Phacops longicaudata*, in which species there is a great prolongation of the caudal extremity into a spine, which is, however, destitute of articulation.

The presence of a facial suture, which I have detected in the species hereafter described, would offer still greater affinity to the Trilobites, as being peculiarly characteristic of that group.

The great difference, in point of time, between the deposit of the lower coal-measures, in which Crustacea of this character first appears, and the upper Jurassic, where they approach very closely to the recent forms, would again account for their closer alliance to the Trilobites, thus leading on in beautiful gradation to that great and important group of the Crustacea which is characteristic, and obtains their maximum development in the older palæozoic rocks.

Two species of the genus Limulus are recorded as occurring in the Muschelkalk, but in the upper Jurassic formation they are found in fine preservation, six species having been described from the cream-coloured

slates of Solenhofen and Pappenheim. They approach much nearer in size and form to the recent Limulus, having distinct legs, with an evidently articulated tail,—the differences, therefore, being so slight, it would, perhaps, be advisable to retain them in the same genus.

The recent forms of Limulus, to which the King Crab belongs, interesting from its relation to these ancient Crustacea, are now most abundant in the seas of warm climates, chiefly in those of India, and on the coasts of America.

The following is the description of the species from the coal-measures, Bilboa Colliery, county of Carlow.

Steropis arcuatus, n. s.

Cephalic shield, semicircular or lunate, slightly arched, declining towards the circumference, and surrounded by a narrow margin which is destitute of spines at its anterior extremity; the central portion, head or glabella, having three ridges extending to about two-thirds of the breadth of the shield, rounded at their anterior extremity, and forming corresponding depressions, the central ridge being broader at the posterior extremity, the two outermost ridges curving at about half their length towards the very slightly raised semicircular eyes, and continuing beyond the posterior extremity of the shield in two sharp, straight spines, which project over the abdomen one-tenth of an inch. The cephalic shield is also produced into a longer spine at the posterior angles, three-tenths of an inch in length, which spreads out on either side from the body. There appears to be a facial suture, commencing at the anterior margin, curving towards the eye, and forming a half circular lid, although it is not perceptible beyond this point. The abdominal and caudal extremities are wanting.

Size of cephalic shield, breadth, 7–10ths of an inch.
" " 3½–10ths "

This species is closely allied, in the form of its cephalic shield, to *Limulus trilobitoides*, figured by Buckland in his "Bridgewater Treatise," Plate XLVI., Fig. 3; and by Prestwich on the "Geology of Coalbrookdale," in the "Geological Transactions of London," second series, vol. V., Plate XLI., Fig. 8.

Portlock, in his "Report on the Geology of Londonderry," &c., figures at Plate XXIV., Fig. 11, from carboniferous shale, Maghera, Derry, a specimen which he refers, although somewhat doubtful, to this species; his figure is destitute of spines, and certainly does not appear to bear much resemblance to the species in question.

There are, however, differences in the specimen under notice which are not exhibited in the figures before alluded to, sufficient to make it a new species. These consist in the two outermost ridges, defining the central part of the cephalic shield or head, being continued over the abdominal segments as spines, and in the great spreading out of the two longer spines at the posterior angles of the shield; as well as in possessing a distinct facial suture.

The great interest attached to this specimen is in the fact of the rare occurrence of remains of this genus in Ireland, and its evident affinity

with similar forms of Crustacea from the lower coal-measures of Coalbrookdale, a formation believed to be of estuary origin, and described by Mr. Prestwich as consisting of alternating beds of sandstone and clay, the strata being between 700 and 800 feet thick, which has yielded between forty and fifty species of terrestrial plants, many species of Mollusca, besides fishes of the genera Megalichthys, Holoptychius, and others, as well as several species of the remarkable Crustacea before alluded to; the specimen now brought before your notice being also found, under somewhat similar conditions, associated with several species of plants and Mollusca.

The following species are now included in the new genus Steropis:—

Steropis arcuatus (*Baily*), *n. s.* Coal-measures, Bilboa Colliery, county of Carlow.

Steropis (*Limulus*) *anthrax* (*Prestwich*). "Geological Transactions," second series, 5, t. 41, Fig. 1–4.

„ „ *rotundus*. Ibid., Fig. 5–7.

„ „ *trilobitoides*. Ibid., Fig. 8; and Buckland's "Bridgewater Treatise," p. 396, t. 46, Fig. 3.

„ „ *trilobitoides* (??). Portlock's "Report," t. 24, Fig. 11.

Synonyms of this Species.

Steropis (*Entomolithus monoculus*). Martin, "Pet. Derb.," t. 45, Fig. 4.

„ (*Bellinurus bellulus*). König, Icon. Sect., Pl. 18, No. 230.

The President stated that this was the first specimen of a Limulus found in those coal-measures.

Mr. Baily stated, in answer to the President, that only three heads had been found, and not the tail.

Professor Kinahan considered the absence of spines a strong confirmation of Mr. Baily's view as to separating these specimens into a new genus.

Mr. Kelly made some remarks.

The President then read the following letter—

ON THE ORIGIN OF MAGNESIAN LIMESTONE. BY CAPTAIN CHARLES P. MOLONY, OF THE MADRAS ARMY.

Various opinions have, from time to time, been put forward regarding the way in which magnesian limestone has been formed. Some say that it is a stratified magnesian limestone. Others deny this, and argue that it must have been formed by infiltration. Others, again, maintain that it was originally a stratified rock formed by the deposition of carbonate of lime, but that it was afterwards altered or changed into a magnesian limestone by the impregnation of magnesian vapours given off by neighbouring igneous rocks when in a heated state. Another party assert that it was at first deposited in regular strata of carbonate of lime, or the common gray limestone, but that, at a subsequent period, water, holding carbonate of magnesia in solution, passed over the rocks, which,

having great absorbent powers, like lump sugar, drank in, in course of time, sufficient carbonate of magnesia from the water to change them into magnesian limestone.

Dr. Apjohn has clearly shown that the rock could not have inhaled magnesia from vapours given off by igneous rocks when in a molten or heated state, as magnesia is not capable of being vaporized.

The almost total absence of fossils in these rocks is also brought forward, "and with truth," as proof that they could not have been originally stratified rocks that were afterwards altered into magnesian limestone either by absorption or by impregnation; for, if they were, the animals that were embedded in the limestone strata at the time of their deposition would still remain in the rocks.

Thus it will be seen this subject is one that has occupied a good deal of attention, and has called forth the expression of various opinions regarding its formation.

One or two things regarding its possible, if not probable, formation have lately suggested themselves to the mind of the writer; and as they may, perhaps, throw some light on the subject, he would beg to offer them.

It is argued by many persons that the great paucity of fossil organic remains in all magnesian limestone rocks is proof that the carbonate of magnesia could not have been deposited contemporaneously with the carbonate of lime. Now, were great abundance of fossil exuviæ, or none at all, to be met with in these rocks, the circumstance might be claimed as pretty conclusive proof in favour of the above argument; but the fact of a *few* fossils only being *occasionally* found in them would appear to the writer to be strong evidence in support of the two carbonates having been deposited at the same time. Carbonate of magnesia may have been held in solution in one sea, and carbonate of lime in solution in another, and the one may have been conveyed to the other by means of currents, as will now be shown.

Mr. Maury, in his excellent work on the Physical Geography of the Sea, fully explains the theory of oceanic currents, their velocity, and power of transporting matter from one sea to another. It is difficult, he says, to form an adequate conception of the immense quantities of solid matter, in solution, which the current from the Atlantic carries into the Mediterranean; and he mentions the circumstance of several vessels having been detained in Almira Bay for three months, in consesequence of the strong currents between that place and Gibraltar, which swept them back whenever they tried to get out.

Now, suppose these currents, which baffled and beat back this fleet for so many days, ran no faster than two knots an hour, assuming its depth to be 400 feet only, and its width seven miles, and that it carried in with it the average proportion of solid matter ($\frac{1}{30}$) contained in sea-water, and admitting these postulates into calculation, it appears that salt enough to make no less than eighty-eight cubic miles of solid matter, of the density of water, were carried into the Mediterranean in these ninety days. Now, unless there were some escape for all this solid matter, which has been running into that sea, not for ninety days merely,

but for ages, it is very clear that the Mediterranean would ere this have been a vat of very strong brine, or a bed of cubic crystals. It may be laid down as a rule, he goes on to say, that all the currents of the ocean owe their origin to difference of specific gravity between the sea-water at one place and the sea-water at another; for wherever there is such a difference, whether it may be owing to difference of temperature or difference of saltness, it is a difference that disturbs equilibrium; and currents are the consequence. The heavier water goes towards the lighter, and the lighter whence the heavier comes; for two fluids differing in specific gravity, and standing at the same level, can no more balance each other than unequal weights in opposite scales. It is immaterial whether this difference of specific gravity be caused by temperature, by the matter held in solution, or by any other thing; the effect is the same, namely, a current.

Now, suppose one sea to have held carbonate of lime in solution, and a neighbouring sea, carbonate of magnesia, then, according to Maury's theory, a surface and under-current from one sea to the other must have been established, by reason of the difference of specific gravity of the two seas,—the specific gravity of magnesia being greater than that of lime; and these currents must have lasted so long as that difference existed, which may have been for thousands of years.

Thus carbonate of magnesia may have flowed into the one ocean, and carbonate of lime into the other, till equilibrium was set up between them, which would have occurred on the proportions having become one to one, or, in other words, when they had mingled together, and gained the ratio to form magnesian limestone; and then an age of tranquillity and subsidence may have commenced, during which the mixed carbonates may have been deposited at the bottom of the sea, and our dolomites and magnesian limestones have been formed.

It is well known, however, too, that at this moment an under-current is flowing in, and an upper-current running out of the Red Sea. That these currents are caused by other causes than the above is true, viz., evaporation; yet the theory is the same, and the result the same—namely, a current or currents, and the accumulation of vast quantities of solid matter.

Knowing, then, that these currents and counter-currents have been going on, almost unceasingly, in various parts of the world ever since we became acquainted with them, and that there is every probability of their doing so for ages to come,—may not the suspended matter and aqueous solutions of one sea have been carried into and become mixed up with those of another, and deposited there in regular strata, and fresh matter have been carried in day after day and year after year, for a continuation of ages, and have been thrown down upon that last formed.

Assuming, then, that such things possibly occurred, it would fully account for the absence of fossils in our magnesian limestone. Carbonate of magnesia being detrimental to vegetation and injurious to animal life, the Fauna of those seas that contained carbonate of lime, finding

their provinces invaded by the influx of so dangerous an enemy, and driven from their old haunts by the noxious fluid, must naturally have sought refuge in other parts of the ocean more congenial to their habits and less fatal to their existence. But some few feeble and worn-out races, unable, perhaps, to accompany their friends, may have been engulfed in the magnesian solution, and not having sufficient strength to extricate themselves from it, may have been embedded in its deposits.

The PRESIDENT then communicated the following paper:—

ANALYSIS OF ANORTHITE FROM THE URAL MOUNTAINS.
BY ROBERT H. SCOTT, A.B.T.C.D.

PROFESSOR G. ROSE having requested me to undertake the analysis of the Felspar of a Diorite which forms the Konschekowskoi Kamm, near Bogoslowsk, in the northern Ural Mountains, I accordingly did so, and found it to be Anorthite; the results of the analysis being:—

		O. ratio.	
Silica,	46·794	24·2969	
Alumina,	33·166	15·5028	17·6338
Peroxide of Iron,	3·043	2·1310	
Lime,	15·968	4·5408	4·9632
Magnesia,	trace.		
Potash,	0·554	0·0939	
Soda,	1·281	0·3285	
	100·806		

The specific gravity of the portion analyzed was 2·72. This mineral is granular, not exhibiting distinct crystalline faces, and is soluble in muriatic acid.

The second constituent of the Diorite, a greenish-black hornblende, has been analyzed by Professor Rammelsberg (Pogg. Ann. 1858, iv. p. 441). His analysis gives—

		O. ratio.
Titanic Acid,	1·01	
Fluorine,	0·25	
Silica,	44·24	22·97
Alumina,	8·85	4·13
Peroxide of Iron,	5·13	1·54
Protoxide of Iron,	11·80	2·62
Lime,	10·82	3·09
Magnesia,	13·46	5·38
Soda,	2·08	0·53
Potash,	0·24	0·04
Loss by ignition,	0·39	
	98·27	

The mineral has a specific gravity of 3·214. It is compact, with perfect cleavage.

The Diorite itself is very coarse-grained, the minerals being distributed through it in irregular masses. It contains also a little quartz, and some brownish-white mica.

The President stated that Mr. Scott's analysis confirmed his own analysis of Anorthite from the Carlingford Mountain.

The Society then adjourned to November.

GENERAL MEETING, WEDNESDAY EVENING, NOVEMBER 10, 1858.

REV. PROFESSOR HAUGHTON, F. R. S., PRESIDENT, in the Chair.

THE following gentlemen were elected Members of the Society:— 1. William Ogilby, Esq., F. R. S., Lisclean, Dunmannagh, county of Tyrone; proposed by Lord Talbot de Malahide, seconded by Dr. Apjohn, 2. William Jones, Esq., C. E., and, 3. George Wilson Irwin, Esq., C. E., both of the General Valuation and Boundary Survey of Ireland; proposed by the Rev. Professor Galbraith and seconded by Professor Downing.

ALPHONSE GAGES, ESQ., read a paper—

ON A METHOD OF OBSERVATION APPLIED TO THE STUDY OF SOME METAMORPHIC ROCKS; AND ON SOME MOLECULAR CHANGES EXHIBITED BY THE ACTION OF ACIDS UPON THEM.

THE following memoranda are an outline of some observations with which I have been recently occupied, and which seem to afford proof, in addition to that advanced by others, of the metamorphic origin of serpentines and other rocks of the same class. In pursuing this investigation, I have paid special attention to the rock-skeletons which result from the decomposition of these and of analogous substances; and I trust that the results at which I have arrived will be found to have an important bearing on an extensive and interesting field of mechanico-chemical geology.

Chemical analysis makes us acquainted with the constituent elements of rocks; but the results thus obtained tell us nothing of the mode of formation of the rocks themselves, or of their intimate structure. In the greater number of instances the different chemical reactions to which it is necessary to submit the various objects of inquiry, present the isolated substances of which they are severally composed in a molecular state, quite different from that in which they primarily existed. It is, then, by a series of comparative experiments that it is possible for us to approach the truth, the most simple experiments being often those which are most effectual; and the importance of the result obtained frequently depends on the mechanical means employed.

The simple action of acids or other dissolvents on a given rock, removing from it certain parts, and leaving others exposed to view, will sometimes enable us to observe its mode of formation, as well as that of

its decomposition. It is important to remark that the mechanical state of the substance to be acted on is not an indifferent element in these experiments; the chemical result will, of course, be the same whether the substance to be acted upon be in the form of powder, of laminæ, more or less fine, of rock fragments, or of crystals cut in the direction of the cleavage; but the true interpretation in reference to the value of the several phenomena observed will be essentially different as regards the geological origin of the object of inquiry.

In support of this proposition I may allude to some examples lately supplied by the experiments which I have made. In taking, for instance, a fibrous dolomite, such as that found near Miask in the Ural Mountains, the ordinary analysis of the mineral will give us a quantity of lime, magnesia, and silica, represented by the following numbers:—

Carbonate of lime,	57·483
,, magnesia,	40·974
Sesquioxide of iron, and alumina,	0·411
Water, and organic matter,	0·239
Silica,	1·095
	100·202*

From this analysis it would appear that the mineral to which I have referred is a dolomite rock; but it affords us no information whatever relative to its real nature or origin. If, however, instead of operating on the mineral in the form of powder or fragments coarsely broken up, we proceed by means of diluted hydrochloric acid acting on a single fragment of moderate dimensions cut in the direction of the fibres, we will observe, after continuing the process for some days, that there will be left an asbestiform skeleton, of which the following is the composition:—

Silica,	68
Magnesia,	29

—numbers representing a magnesian Tremolite; and it is from this simple difference in the manner of conducting the experiment that we have arrived at a result so different from the former, thus enabling us to trace, so to speak, the real origin of the rock in question.

In many instances some varieties of magnesite (siliceous carbonate of magnesia), analogously treated by a solution of dilute hydrochloric acid, leave silico-gelatinous residues, thus affording indications, as in the former case, of the origin of the rocks from which they are derived; another case in point being the possibility of following the transition from meerschaum, which is a silicate of magnesia in definite proportions, to a replacing pseudo-morphite of ordinary carbonate of magnesia, containing mere traces of gelatinous silica.

The manner in which concentrated hydrochloric acid acts upon

* "Phil. Mag." for March, 1858, and "Jour. of Geol. Soc. of Dublin," vol. viii., p. 39.

crystals of certain varieties of zeolites with alkaline bases shows, from the partial decomposition effected, the stages through which these minerals pass. A crystal of Thomsonite, boiled with hydrochloric acid, deposits, after saturation of the alkali, a gelatinous transparent precipitate of silica, and an opaline siliceous skeleton remains, which to a certain extent preserves the form of the primitive crystal. A mass of these crystals treated in the same manner, and dried after separation of the gelatinous silica, resembles, to all appearance, that of the siliceous aggregates which are often found in Solfataras; and the gelatinous deposits occurring in such volcanic localities, as well as near some thermal sources, have, doubtless, often been formed in the same manner.

I may further refer to the results obtained by operating upon a variety of magnesite derived from the decomposition of trap rock, and described by General Portlock in his Geological Report on the Counties of Londonderry, Tyrone, and Fermanagh, pp. 114 and 115. This mineral substance presents one of the best illustrations of the peculiar metamorphic changes which occur in the decomposition of basalt rocks. Dr. Apjohn has given an analysis of the mineral at page 114 of the Report I have mentioned, from which it would appear to be a hydrous silicate of alumina and magnesia. This mineral substance is of a grayish-white colour, and consists of a series of parallel laminæ. A lamina of this mineral, of about two centimetres square, by two millimetres thick, being boiled for a certain length of time with hydrochloric acid, and afterwards with sulphuric acid, leaves, after an operation of several days, a skeleton of amorphous silica, blackened by the sulphuric acid acting upon organic matter, which has been derived, doubtless, from the water of infiltration. Upon the acid and organic matter being removed by washing and combustion, there remains a skeleton of pure amorphous silica, having a density less than that of water, and presenting the perfect form of the primitive substance, in which will be found exhibited to the naked eye the laminæ superimposed like the leaves of a book. After immersion in water for a sufficient length of time, it becomes translucent, and acquires all the characters of certain varieties of hydrophane. The quantity of water which it absorbs is more than 115 per cent. If left exposed to the air for some time, the siliceous skeleton loses the greater part of the water, but retains a mean quantity of about 6·40 per cent, which corresponds very nearly with the formula $3Si, O_3, \dot{H}O$ given by Beudant of an opaque white opal of Castellamonte.

If it be immersed in a solution of ammoniacal sulphate of copper, and afterwards exposed to the open air, it retains a portion of the copper salt, even though subjected to repeated washings, and in the moist state it presents the appearance of certain varieties of silicate of copper (copper hydrophane).* In sulphuric acid the substance becomes hyaline,

* This phenomenon may be explained by the great difference existing between the refractive power of air and sulphuric acid.

and retains a portion of the acid with great tenacity, even after repeated washings. A solution of caustic potash dissolves the skeleton with great facility, even after submitting it to a red heat.

Although it seems difficult to ascribe a capability to this siliceous matter of forming definite compounds, the facts just mentioned are not the less remarkable. The molecular condition in which the silica exists in such an alumino-magnesian compound as I have described, and the action which it exerts on a great number of liquids and solids, would appear to indicate a point of connexion between chemical phenomena and the forces of molecular attraction.

As an illustration of the decomposition and subsequent reconstruction of rocks, I have also examined a pseudo-morphite of quartz rock, in all probability derived from magnesite, and obtained from nearly the same locality as the former mineral, which, like it, was composed of a series of parallel laminæ: the interior layers possessed a certain amount of permeability, which, upon examination with a lens, showed that the silica had passed into the crystalline state, but, notwithstanding, some traces of amorphous silica could still be detected by the test of caustic potash. The density of this pseudomorph is nearly the same as that of ordinary quartz rock. It would appear, therefore, that the alumino-magnesian bases of the original rock having disappeared, a permeable siliceous skeleton remained, which had been subsequently infiltrated by the silica of the alkaline silicates derived from the decomposition of the surrounding trap rocks.

To the same class of phenomena we may probably refer those resulting in the petrifaction of the fossil wood occurring in the vicinity of Lough Neagh, which, according to Bischof, contains 71 per cent. of silica; and the slight alkaline reaction which the same observer has attributed to the waters of that lake apparently also supports this view.

The mineral substances called mountain leather and mountain cork, which are chiefly derived from the decomposition of hornblendic rocks, as in the county of Londonderry, exhibiting, as it were, in themselves a kind of natural process similar to that described, leave, when treated with acid, a spongy skeleton of excessive lightness, which swims in water, and bears the greatest analogy to some varieties of nectic quartz. This residue of silica absorbs about four times its weight of water, and rapidly dissolves in a weak solution of caustic potash (cold), even after the skeleton has been heated to redness. The mineral substances just referred to, as well as analogous compounds, are in a more or less advanced stage of decomposition; the portion of them remaining being often only a spongy, aluminous silicate, which has itself been partially decomposed, the silicates, in greater or less quantity, having been removed and replaced by carbonates of lime and magnesia; but I may remark that the silica retained in these minerals is always found in the amorphous soluble state, which appears to me conclusive as to their origin; sometimes either carbonate of lime or of magnesia, or both, completely replace the original siliceous compound forming the mountain leather, which in

that case can often only be traced as a thin coating on both sides of the newly formed carbonates which occupy the place of the decomposed silicates of lime and magnesia. The thin coating to which I have alluded is occasionally almost imperceptible; but a practised observer will find no great difficulty in detecting it. Pursuing the same view, I may observe that serpentine cut into thin pieces of various shapes, and treated by acids, also exhibit in a great number of cases the original mineral substances from which it is derived, always leaving, however, a siliceous skeleton, in which those substances are nearly always enclosed; and this skeleton, being opalescent in water, likewise possesses some of the other properties before mentioned. This mode of treatment by various dissolvents enables us at once to account for the variations which have occurred in many of the published analyses of serpentine; since, in the majority of instances, the skeleton will be found to envelope, in greater or less quantity, the mineral matter partly decomposed, from which the serpentine originated, a fact which will, of course, exercise a very variable influence with respect to the analytical results. My experiments on this subject are not as yet sufficiently advanced to offer more than a few concluding remarks respecting some further properties which I have lately discovered in connexion with the skeletons of some of the specimens of serpentine examined, in two of which I have succeeded in detecting the presence of organic matter under the action of concentrated sulphuric acid. One of these is from the neighbourhood of Holyhead, and the other from Snarum in Norway. The serpentine from Norway is of a yellowish-green colour, with undulating lines of light green; and its skeleton, which is almost entirely soluble when submitted to the action of caustic potash, shows small micaceous spangles of talc, and also black spots which appear to be derived from decomposed garnets. It absorbs about 40 per cent. of water, becoming translucent, and is of a rather compact structure. The serpentine from the neighbourhood of Holyhead, treated with sulphuric acid, presents marks of carbonization, but it is only at certain isolated points; and the undecomposed portion exhibits well-defined lines of cleavage.

The serpentine of Galway, though of a variable character, is more or less readily acted upon by acids, both according to the state of alteration by which it has been affected, and the quantity of carbonate of lime which it contains, this latter being often uniformly disseminated throughout the mass. The skeleton which it leaves is in general very friable, and falls into powder on drying; the part not affected by the employment of caustic potash is formed by an agglomeration of micaceous spangles of talc, and also insoluble silica; the green colour is produced chiefly by protoxide of iron, which forms the irregular veins observable.

In the serpentine of Penzance, coloured chiefly by peroxide of iron, the siliceous skeleton envelopes a nucleus unaffected by the action of acid which consists of an aggregation of hornblendic and diallagic substances, which, as it were, may be viewed as a skeleton within a skele-

ton. By the simple process which I have endeavoured to describe, namely, the submission of thin laminæ to the influence of acids and other dissolvents, true serpentines, which are hydrated minerals, leaving siliceous skeletons of amorphous silica, may be distinguished at once from many other rocks, which latter are often merely altered clay slate, so nearly resembling serpentines lithologically, as to have been frequently confounded with them, though quite distinct in chemical composition. I might have cited several other examples in support of the foregoing theory, were it consistent with the limits usually prescribed for a paper purporting to be a mere outline; but their omission causes me the less regret, as I am still prosecuting this subject, owing to the encouragement which I received from the British Association to complete the inquiry.

The President made some remarks on Mr. Gages' paper, especially with reference to the origin of serpentine, which he did not consider to be igneous. He had carefully examined the serpentine of Holyhead, the Lizard, and Galway, and in none of them did he see indications of such an origin.

Dr. Apjohn congratulated the members on the very interesting paper read by Mr. Gages, and trusted he would still continue his observations.

Dr. E. Perceval Wright read the following paper by Henry J. B. Hargrave, C.E.:—

ON THE GENERAL GEOLOGICAL FEATURES OBSERVABLE ON THE SEA-SHORE BETWEEN BALBRIGGAN AND RUSH.

The first object of geological importance occurring near the pier of Balbriggan is a greenstone quarry, of a uniform greenish-white colour and compact structure, but apparently presenting nothing further worthy of special observation.

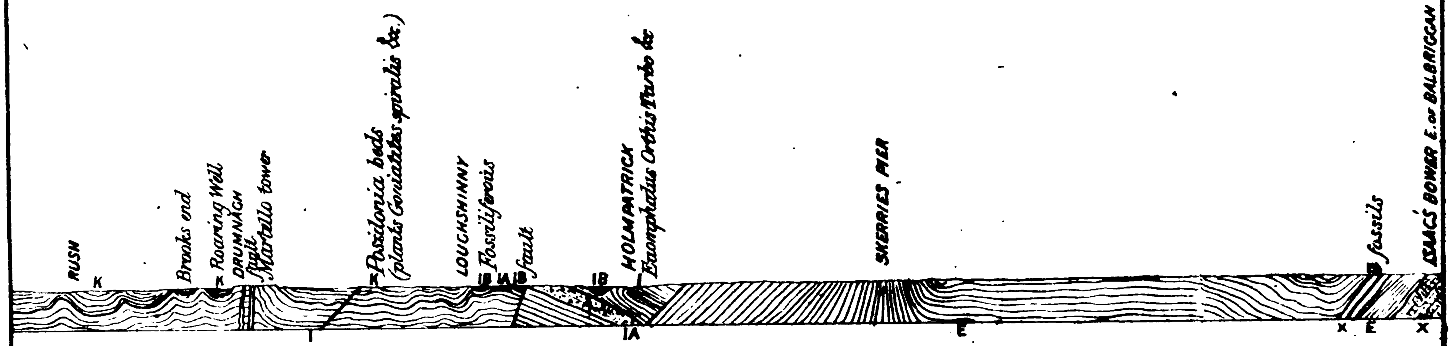
Upon arriving at the shore, which is not far distant from the above quarry, there would not appear to be any rocks visible *in situ*, if we except projections of greenstone occurring here and there at distant intervals, just like boulders, though, from their proximity to the quarry I have mentioned, they may not be so.

The headlands are formed of clay, and seem to present no peculiar feature: the pebbles on the shore are for the most part composed of greenstone, though sandstone and syenite are occasionally met with.

Proceeding southward, the first object of interest occurs at a place called Isaac's Bower, where for the first time on the shore a continuous formation of apparently stratified rock, in beds of from 18 inches to 2 feet thick, occurs. This rock is of a dark green colour, and as it does not seem to be acted upon by hydrochloric acid (cold), it may possibly be a mixture of felspar and hornblende; but in any case its present position is evidently due to volcanic agency. It is at this point, a little below Isaac's Bower, that we come to the northern limit

Section between Balbriggan and Rush (Length 651 Chains)

Scale 1¼ Miles (statute) to One Inch



Reference

K. Calp
I.B. Dolomitic
I.A. Conglomerate
I. Lower Limestone
E.D. Silurian limestone
E. Silurian slate
X. Trap

of the section* which I have prepared, and the first junction observable is that between this trap and the stratified Silurian slate, which latter dips at a high angle, say between 50° and 60°. These beds are very thin, and do not seem to have been altered in contact with the volcanic rock before mentioned. The trap would appear to have been intrusive rather than contemporaneous, from its occurrence, a little further south, as a thin band, between two beds of limestone, which are interstratified with the mass of the Silurian rocks (*vide* section), the line of bedding having probably offered least resistance to its onward flow, though we might infer otherwise from its apparent stratification and non-metamorphic action. The limestone referred to strikingly contrasts, both in colour and structure, with the surrounding Silurians, being in thick beds, and of a light blue colour, effervescing strongly with hydrochloric acid. The limestone (*vide* specimen) pàsses into a black slate, having numerous sedimentary lines, which much resembles the calp of the district (*vide* specimen), being possibly analogous to the graptolite slate of the commons of Slane, in the county of Meath; and I may observe that the limestone with which it is connected has formerly been observed to be fossiliferous by Sir Richard Griffith, Bart. As we advance in the section, the Silurian slate assumes a more solid structure, forming in thick beds, which, after exhibiting some fine contortions, become nearly horizontal, the general dip being in a northerly direction.

Passing the Ardgillan bathing-place, rock is no longer visible, the cliffs, which form a bay, with a sandy beach, presenting the most prominent feature, as well as that most worthy of notice (*vide* map). These cliffs are formed of stratified sands, which exhibit lines of false bedding, with bands of clay and fine gravel intercalated, and as they contain marine fossils, such as Turritella and *Cyprina islandica,* I conclude they were of drift origin. The pebbles, which are of much worn red sandstone and red flint, indicate, I should say, the northern direction from which they had been transported.

The railway passes through a sand-hill of similar origin near the Skerries station, which, amongst others forming a prominent feature near the town, exhibits very perfectly the appearance of false stratification, to which I have alluded; and I may remark the occurrence of an angular pebble of granite in a neighbouring sand-pit (*vide* map). In the bay above mentioned I observed two large boulders of greenstone, having crystals of felspar.

At the southern head of the bay the Silurian rocks reappear, their strike being altered; but they still present the massive structure before observed, till we approach the town of Skerries, where they become vertical, and disappear. On the shore of Skerries we only find rock at Red Island, where the strike appears to agree nearly with that of the rocks occurring at the head of the bay before referred to; but, from the confusion existing, it is difficult of identification; the dip, however, on the south side of the island is towards the south.

* See Plate III.

Proceeding still southward, beds of rock appear for the first time opposite to Shennick's Island (*vide* map), which, as they form, in my opinion, the commencement of the lower limestone, I have represented as resting unconformably upon the Silurians,—a view borne out, I would say, by the fact of the Silurian rocks, last mentioned, dipping towards the south; while these dip towards the north, the line of junction being determinable only by observations made in the interior of the country (*vide* map). This limestone is of a light blue colour, and subcrystalline structure, having a very uniform appearance; and may be well observed at Milverton quarry, where it is chiefly worked for the agricultural purposes of the district, as well as for building. When first observed, it is very horizontal, and the strike is rather indefinite, the beds presenting a series of undulations. In one of these undulations, a little farther south, a deposit occurs, which differs from the subjacent limestone, being very crystalline, and of a yellowish colour (*vide* specimen). This is also a limestone, though probably magnesian. If pulverized, and immersed in dilute acid, it effervesces, but leaves a considerable residue. The presumed magnesian deposit continues interruptedly for a short distance, the subjacent blue limestone being exposed at intervals by the removal of the overlying deposit from the erosive action of the sea-water; and blocks of blue limestone may frequently be observed to be coated with this crystalline yellow limestone, from which the whole formation may be fairly inferred to have had a similar origin, the sedimentary agencies being occasionally more or less subject to magnesian conditions.

Conglomerate in very thick beds, overlying the blue limestone conformably, is next met with, and it is chiefly composed of green slates, which vary in size from a foot downwards, being cemented by a calcareous paste, which also contains pebbles of quartz rounded by previous attrition. These beds continue uninterruptedly for about a quarter of a mile, when we again meet, at least in my opinion, the continuation of the blue limestone before mentioned, reappearing from beneath the conglomerate.

Though I have not adopted this view in the section, from the apparent unlikelihood of the limestone forming a reversed synclinal flexure of such a distorted character, enveloping the conglomerate, I yet think that the probabilities are in favour of the supposition, that while the limestone was being deposited, the materials of which the conglomerate is composed were being prepared near a Silurian shore, and, by the simultaneous action of the carboniferous waters, were deposited in a calcareous paste, which would have formed the bed overlying the subjacent limestone, both having been subsequently subjected in a moist state to the lateral disturbances, of which there is such abundant evidence throughout the district. That the limestone at least underwent disturbance while in a very plastic condition, appears to be highly probable, from the fact that both at the Milverton and M'Court's quarries crinoid stems (see specimen) may be seen projecting, like nails in a wall, from the faces of joints coated with clay which have been exposed by blasting, as, had

the rock been fractured in a brittle and indurated state, we might have expected that the crinoid stems, being broken across, would have exhibited a cross-section, coinciding with the plane of the joint, especially as the joints would seem to have been unaffected by the action of weather or other external influences.

In M'Court's quarry (*vide* map), which is probably a continuation of the limestone already referred to, at the southern extremity of the conglomerate, I obtained several fossils (*vide* specimen), amongst which I observed *Euomphalus pentangulatus*, *Naticopsis Philipsii*, *Spirifer glaber*, *Terebratula acuminata*, and a new variety of *Orthis crenistria*, remarkable for its lateral granulation. It was in this quarry that Dr. Davy, of the Royal Dublin Society, obtained the beautiful specimen of *Turbo tiara*, which he exhibited at one of the Evening Meetings of the members of that body. An isolated outlier of conglomerate, similar to the last mentioned, though formed of finer materials, occurs a little further on, and, in my opinion, affords additional evidence in reference to the views I have been advocating; as, had the underlying limestone been formed for any length of time prior to the deposition of the conglomerate, the broken-up shingle of the previously consolidated rock would necessarily have formed a portion of the materials of which the superincumbent conglomerate was composed. Ascending in the section, we find the calp in succession, distinguished by its dark carboniferous appearance. This formation consists of dark-coloured, impure, compact limestone, interstratified with dark shales, which exhibit a semi-crystalline structure, graduating into shaly laminations of extreme softness, easily impressed by a blow of the hammer. It was in these beds that the *Posidonia Becheri*, showing both valves, was obtained by Sir Richard Griffith; and in a late excursion made with Mr. Haughton, I was successful in procuring another example of the same structure at Loughshinny. Both specimens have been figured by Sir Richard Griffith in the last Number of the "Journal of the Geological Society of Dublin." I also observed the occurrence in the Posidonia beds of the fossils, such as *Goniatites*, and plant remains, which have been previously noticed in the Journal referred to.

The origin of the Calp formation is so well known, and has been already so often discussed, that I can do little more than corroborate the opinion that these strata formed the bed of an ancient marine slob, which was gradually augmented by incursions of mud mingled with organic matter, such as the leaves and stems of trees, &c.

The lower limestone, in thick beds, and very much contorted, reappears at the headland of Drumnagh, there being nothing further worthy of remark, if we except the occurrence of a fault (*vide* section), in the vicinity of which a fissure of large dimensions has been formed, evidently much subsequent to the consolidation of the fractured rocks; and it contains masses of the surrounding limestone, cemented by a matrix of white quartz. Passing Drumnagh (*vide* section), the shale and limestone alternately appear at the surface, little beyond the variety of dip exhibited

by the shales attracting our attention as far as the town of Rush, at the pier of which, however, the alternating strata of blue limestone and shale become very much confused, the last-mentioned occasionally assuming a light colour, so like the former as to be undiscernible at first sight.

From my general observations it would appear that the numerous remarkable flexures and contortions which are characteristic of this shore, afford evidence, from the invariable northern direction of their anticlinal slopes, as well as from the southern dip of the axis of their curves, that the strata had been subjected to a great horizontal pressure from the south and towards the north, as has been lately observed by Professor Haughton in connexion with a reversed fault occurring on this shore, the fractured line of which dips to the south.

I have only to remark, in conclusion, that the supposititious synclinal reversion of the limestone enveloping the conglomerate to which I have alluded, would seem to owe additional probability to some such pushing influence as that I have described, the greater inflexibility of the conglomerate, risen together with the underlying limestone at the southern extremity, causing both to move rigidly forward from the south in an inclined direction, by the force of which the yielding limestone, rising up under the northern edge of the conglomerate, would be bent round to form a reversed curve, the overlapping limestone being thus a continuation of the subjacent bed, and not a superimposed succession, as may be illustrated by a simple experiment. A lateral pressure applied to any yielding material of sufficient length, such as India-rubber or woollen cloth, to a given portion of the plane of which a coinciding flat solid of an inflexible character being attached, will produce a model of every flexure generally observable on this shore, including that which envelops the conglomerate, as the curve in the model which represents this latter will be found, unlike all the remaining flexures, to exhibit a similarity to the peculiar character of the synclinal reversion which I have attempted to describe.

The foregoing observations are the result of a survey made with a view to my University Diploma as a Civil Engineer, and though much imperfection will necessarily attach to the examination of a district presenting more than ordinary difficulties, I trust that I may have been enabled, even in a slight degree, to increase the store of local observation already in our possession, as in such case I shall be gratified to feel that my endeavours, of how humble a character soever, shall not have been wholly unavailing.

Mr. J. Beete Jukes said that the part of the coast selected was one of unusual difficulty, and that he had great pleasure in seeing the manner in which Mr. Hargrave had examined the coast-line.

A vote of thanks was moved by J. Beete Jukes, Esq., seconded by Dr. Whitty, to Mr. Hargrave.

The Meeting of the Society was then adjourned till the 8th of December.

GENERAL MEETING, DECEMBER 8, 1858.

REV. PROFESSOR HAUGHTON, F. R. S., PRESIDENT, in the Chair.

THE following gentlemen were elected as Associate Members of the Society for the Session:—1. Henry Thomas Geoghegan, Esq., 4, Upper Merrion-street; 2. Edmund Butler, Esq., 3, Corrig-avenue, Kingstown; 3. John Classon Stephens, Esq., 4, Blackhall-place: proposed by Dr. E. Perceval Wright, seconded by J. Beete Jukes, Esq.

The REV. EUGENE O'MEARA read a paper—

ON THE OCCURRENCE OF RECENT DIATOMACEÆ IN THE LOWER TERTIARIES OF HAMPSHIRE.

THE matter in which the Diatomaceæ forms referred to were found was collected by Dr. Frazer from the chambers of fossil shells belonging to the Hampshire beds. These beds, which lie low down among the tertiary rocks, are described in the following extract from Brander's preface to his "Fossilia Hautoniensia:"—"The fossil shells, of which the following plates are exact drafts, were collected in the county of Hampshire, out of the cliffs by the sea-coast between Christ Church and Lymington, but more especially about the cliffs by the village of Hordwell, which is nearly midway between the two former places. They are found in their natural state, excepting their loss of colour, and exceedingly well preserved, below a stratum of gravel and sand about fourteen or fifteen feet thick, in a bluish kind of clay or marl, quite down to the level of the sea; how much deeper is not known. The height of the cliffs in many places is above one hundred feet." The matter, "a bluish kind of clay or marl," was very dry—a circumstance which afforded the hope of obtaining such diatomaceous forms as might be included more readily than by the ordinary process of treatment with acid. The method adopted was that of throwing the matter very gently into a glassful of water; the sand immediately fell to the bottom, and the lighter particles, as was anticipated, in the form of a thin film, floated on the surface. After the lapse of some hours, this film was carefully skimmed and examined. On examination, two forms incident to brackish water were found, but no sign of salt-water specimens occurred, except one small fragment of *Coscinodiscus radiatus*. All the species were such as are found in fresh water, and which are of frequent occurrence at the present time. On the ground of novelty, therefore, there was nothing of interest in the result of the investigation. It was, however, remarkable that, although the species of Molluscs, the remains of which have been found in the Hampshire beds, have become almost, if not altogether, extinct, the diatomaceous forms found along with them were all identical with existing species. The list of the species found will be given in the account of the January meeting.

R. Scott, Esq., exhibited a specimen of clay from Oberhohe, which contained 90 per cent. of silica, and was full of Diatomaceæ.

The President next made a communication to the Society relative to the coal of Labuan and Borneo, respecting the value of which some discussion had recently arisen. Mr. Motley had published in 1852, in the "Journal of the Indian Archipelago," a geological account of this coal, from which there could be little doubt left as to its being a tertiary coal, containing a good deal of rosin; and he even identified some of the trunks and leaves of the trees comprising the coal-bed with some still growing in the island, belonging to the natural family of the Dipteraceæ. The President believed that the question of quantity and quality had not received the share of attention it was worthy of, and he therefore wished to place on record the following documents, which he had received from a trustworthy source. The first letter is from a gentleman in the Dutch service, who had peculiar facilities for ascertaining the facts he mentions:—

No. 1. "In compliance with your request, I have the honour of stating that the Borneo coal gives every satisfaction for the purposes of steam coal, and has during the last years been extensively used by the vessels of the Dutch Royal Navy and private companies—so much so, that the import of coals from Europe in the Dutch East Indian possessions has of late entirely ceased. The imperfect working of the mines in Borneo did render the price often dearer than the imported article; but this fact notwithstanding, such is their superiority, that the former has gradually driven the latter out of the market. This information is the fruit of personal experience during my residency in the Island of Java, and you may therefore rely on its accuracy."

From one of the letters read by the President, it would appear that many thousand tons of this coal have been already used by the Peninsular and Oriental Company and others, and that the quality of the coal is good. One of the engineers states "that the consumption of Labuan coals appears to be more than the north country coals, which we generally use: they burn freely, make a strong, clear fire, and generate steam very quickly; they are likewise very clean, making very few clinkers." Another engineer states that "the quantity of clinkers and ashes deposited averages 3 qrs. 16 lbs. per ton of coals."

Mr. J. Beete Jukes, F. R. S., read a paper, by Mr. Du Noyer and himself,—

ON THE GEOLOGICAL STRUCTURE OF CAHERCONREE MOUNTAIN, TEN MILES WEST OF TRALEE.

Immediately south of the town of Tralee is the Slieve Mish range of mountains, formed by an anticlinal curve of the Old Red Sandstone. The axis of this curve is slightly inclined to the east, so that in that direction it gradually disappears, the sides of it flattening, and the carboniferous limestone curving round the terminating fold of Old Red Sand-

stone. Towards the west the axis gradually rises; the mountains also become loftier in that direction; but their summits do not rise quite so fast as the axis of the anticlinal; consequently, lower and still lower beds sweep over the crest of the ridge as we proceed towards the west, or are exposed in the valleys that traverse it.

Two of these valleys are very remarkable glens: one called the Glen of Curraheen; the other, the Glen of Derrymore. In the Curraheen Glen the lowest beds appear at first sight to dip to the south, at angles of 30° and 35°, with the conglomerates of the Old Red nearly horizontal upon them. We believe, however, that this apparent dip in the lower beds is due to oblique lamination on a large scale,* and not to true stratification, and that the whole of these beds are Old Red Sandstone. In the Derrymore Glen, however, the conglomerate of the Old Red Sandstone rests upon a perfectly distinct set of beds, dark-gray flags and slates, containing Upper Silurian fossils in considerable abundance in some places, together with some purple beds. Between the two glens just named is the Mountain of Baurtregaum (or Head of the Three Glens), 2796 feet above the sea.

Just west of Derrymore Glen is Caherconree, 2713 feet high, having a broad and steep slope towards the west into the valley of the Finglas River, which extends nearly across the range, and separates the Slieve Mish mountains from those further west.

Standing in Derrymore Glen, and looking west towards Caherconree, a very remarkable section is plainly seen in some lofty precipices that environ the upper end of the glen.

The Silurian rocks, which are a good deal contorted, end in a steep precipice of about 500 feet, nearly vertical, against which the horizontal beds of Old Red Sandstone have been deposited. That this feature is not the result of any dislocation subsequent to the formation of the Old Red Sandstone is shown by the fact that the beds of that formation stretch across the top of this Silurian precipice in unbroken sheets of a conglomerate containing quartz pebbles, that can be traced, in all directions, for a considerable distance, those conglomerates resting on the one side on the Silurian rocks, and reposing on the other on other beds of conglomerate that can be traced round one side of the glen, and for several miles in the S. W. direction. These latter lower beds of conglomerate are of a very remarkable character, containing angular blocks, fragments of mica schist, gneiss, felstone, slate, &c. No gneiss or mica schist is now known in the neighbourhood, or anywhere nearer than Galway; yet some of these blocks are a foot in diameter,† and but very slightly rounded at the corners. The conglomerate which we call the Inch

* Almost equally extensive oblique lamination is clearly visible along the coast near Anascaul in the Old Red Sandstone.

† One block was 1 foot 8 inches by 10 inches. Some blocks of grit are more than 2 feet in each direction.

Conglomerate, from the name of a place on the south coast where it is well seen, dies away towards the west, and, from a thickness of 400 feet in Derrymore Glen, thins out to six feet near Minard, where it terminates to the west.

The Silurian cliff may be traced along the east side of Derrymore Glen, and appears again on the other side of Caherconree, running along the S. W. direction of the Finglas valley.

The western slope of Caherconree exposes in some places, about its centre, and not very far below the summit of the hill, beds containning Wenlock fossils, and in one place a concretionary hard limestone, mottled green and red. This limestone is made up of masses of coral; but contains shells and other fossils, of which a list is given below by Mr. Baily.

The quantity of rock shown is unfortunately not sufficient to enable us to make out its relations very exactly, beyond the fact of the beds being in considerable mass, in highly inclined positions, and undoubtedly *in situ*, since the flags are the same as those seen, in much larger quantity, in Derrymore Glen, and evidently strike from one place to the other through the heart of the mountain.

Other beds of slate of a dark gray colour, associated with beds of green and purple hues, are seen lower down on the west slopes of Caherconree, both to the north and to the south, apparently much contorted. These beds strike generally to the W. S.W. along the valley of Anascaul, and terminate at Minard Bay and Bull's Head, sixteen miles to the westward.

Just north of Bull's Head, in a little cove called Coosathorrig, we again find fossiliferous beds, containing calcareous masses of similar mineral character, and with similar fossils to those in Caherconree.

North of the Anascaul valley are some very thick beds, which we call the Dingle Beds, made of dark-brown sandstone flags and slates, with purple conglomerates, which generally dip south towards the Silurians of the Anascaul valley.

Some of these beds likewise appear in the Finglas valley, also dipping south, at angles of 60° to 80°, towards the Silurian. What are the relations of these two groups of beds is a puzzle that we have not been able to arrive at any solution of.

Over them lie the Old Red Sandstone and Conglomerate quite unconformably, sweeping across their edges, and stretching from them on to the edges of the Silurian beds.

The President observed that several of the pebbles forming the conglomerate appeared to him to be granite, of a description similar to the granite with white mica, characteristic of the Leinster chain.

It appeared to him to be a very remarkable fact that this granite should occur as a constituent of the Cahirconree Old Red Sandstone Conglomerates; and he might mention that he had himself observed granite in pebbles of conglomerate of the county of Waterford, at Rath-

moylan Cove, in a deposit of the same geological age. These facts would go far to establish a transport of materials to the south-west during the Red Sandstone period in Ireland.

Mr. Du Noyer explained several very remarkable facts about oblique laminations in this district, which had all the appearance of unconformability at first sight.

LIST OF FOSSILS FROM WEST FLANK OF CAHERCONREE, COUNTY OF KERRY, DETERMINED BY MR. W. H. BAILY.

Graptolithus priodon.	Alveolites repens.
Orthoceras subundulatum (*Portl.*)	Rhynchonella borealis.
Calymene Blumenbachii.	Strophomena depressa.

FROM DERRYMORE GLEN, UPPER LUDLOW.

Encrinites.

Periechocrinus moniliformis.

Brachiopoda.

Rhynchonella borealis.	Leptæna sericea.
„ nucula.	Orthis elegantula.
Spirifer elevatus.	Strophomena filosa.

Atrypa reticularis.

Conchifera.	*Crustacea.*
Pterinea fimbriata.	Calymene tuberculosa.
„ orbicularis.	Proetus latifrons.
Avicula retroflexa.	

Mr. W. H. Baily then read the following—

NOTICE OF UPPER SILURIAN FOSSILS FROM BALLYCAR SOUTH, COUNTY OF CLARE, ONE MILE AND A HALF WEST OF THE VILLAGE OF TROUGH.

The object of this communication is merely to record the fact of the discovery of upper Silurian fossils at the above locality by Messrs. Du Noyer, Kinahan, Foote, and Wynne. The following is a list of the species collected by those gentlemen:—

Zoophyta.	Specimens.
Petraia sub-duplicata or elongata, ...	25
Petraia (?) Du Noyeri (*n. s.*) (*Baily*), ...	2

Brachiopoda.

Strophomena euglypha,	5
,, depressa,	10
Orthis elegantula,	15
Atrypa reticularis,	2
Spirifer crispus, or elevatus,	6

Gasteropoda.

Euomphalus funatus,	4
,, lautus,	1

Crustacea.

Encrinurus punctatus,	2
Proetus latifrons,	6

Advantage may also be taken of this opportunity to mention the finding by Mr. Wynne and myself of the following fossils in the Lower Silurian (?) district of the Devil's-Bit range, in the county of Tipperary, at places called Reaghfadda, Dooree, and Garran Green.

COUNTY OF TIPPERARY, LOWER SILURIAN.

Echinodermata.

Actinocrinus (?) Wynnei (*n. s.*), joints of crinoid stems; Reaghfadda.

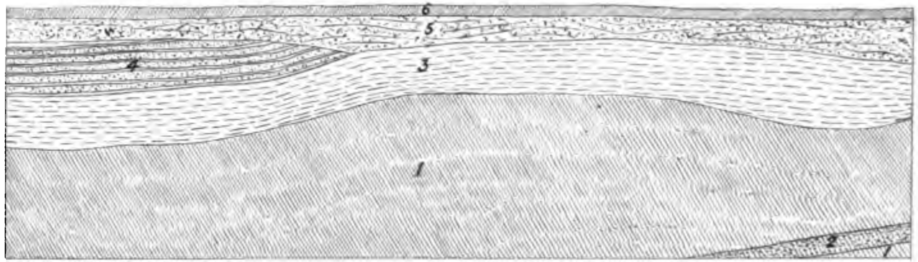
Zoophyta.

Graptolithus priodon.
,, convolutus.
,, sagittarius.
,, tenuis.

Mollusca.

Orthis elegantula (?).
Conocardium pristis (*Salter*).
Cardiola interrupta.
Orthoceras lineatum (*His.*).
,, elongato-cinctum (*Portl.*).
,, tenui-cinctum.
,, ibex, or perelegans.
,, pseudo-regulare (*Portl.*).
Theca triangularis (?)

Section No. 6



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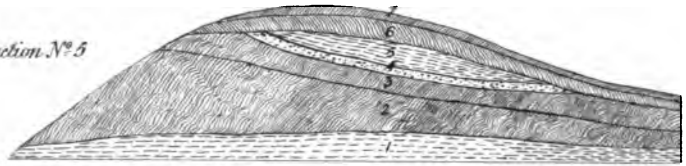

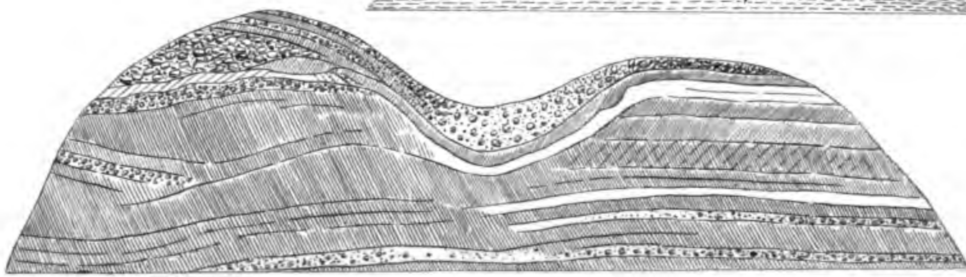

Section No. 4

GENERAL MEETING, JANUARY 12, 1859.

REV. PROFESSOR HAUGHTON, F. T. C. D., F. R. S., President, in the Chair.

THE Minutes of last Meeting having been read and confirmed, donations were announced, and thanks voted to the donors.

The following gentlemen were elected as Members of the Society:— 1. Major Leach, R. E., Phœnix Park: proposed by J. B. Jukes, F. R. S., seconded by Dr. E. Perceval Wright. 2. Mr. John Hill, County Surveyor, King's County, Tullamore: proposed by G. Alexander Tate, Esq., seconded by G. B. Murray, Esq.

MR. J. BEETE JUKES read a paper by Mr. J. BIRMINGHAM—

ON THE DRIFT OF WEST GALWAY AND THE EASTERN PARTS OF MAYO. (SECOND NOTICE.)

AT the last January Meeting of the Society I ventured to put forward my views respecting the drifts of the above district. Since that time I have carefully extended my observations, and have seen nothing to make me alter my opinions regarding the aqueous agencies that operated in the formation of the escars and other similar deposits. My idea that, as a general rule, the presence or absence of stratification depends on the character of the drifted materials, I have seen everywhere confirmed; and, even in matter least favourable to bedding, I have frequently observed attempts at sedimentary arrangement. An example of this may be seen in the most western of the drift cliffs of Barna, near Galway, where the tenacious clay and striated boulders, which are now forming a conglomerate at the base, present very obvious signs of stratification. I have tried to represent a part of this cliff in a section* where *a* and *c* are nearly amorphous clay and coarse limestone gravel, with indications of bedding; *b*, a stratum of fine sand in *a*; *d*, a fine sand in almost horizontal layers, and *e*, the surface bed of red granitic soil. The adjacent cliffs are formed altogether of coarse gravel and boulders embedded in clay, and, containing no fine sand, are of an amorphous character throughout. None of these cliffs present the indications attributed to glacial deposits, the lower parts of which are said to be unstratified, while the upper portions display the effects of disturbance and arrangement by water.

The escars frequently present examples of very perfect bedding, and, like the cliff in Section No. 1, often show successive processes of wear and reaggeration. This may be observed in various localities within my district; but I have seen it nowhere to more advantage than in the railway cuttings through escars near Athlone (see Sections Nos. 2 and 3).

In cross-sections of the escars it is easily seen that the sandy beds generally agree, more or less, with the curved outline of the hills; but

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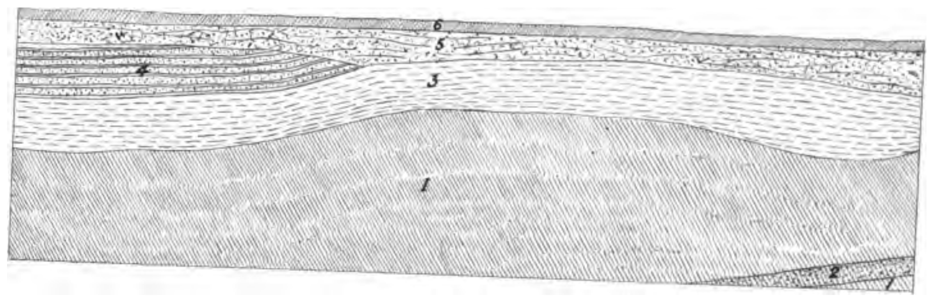
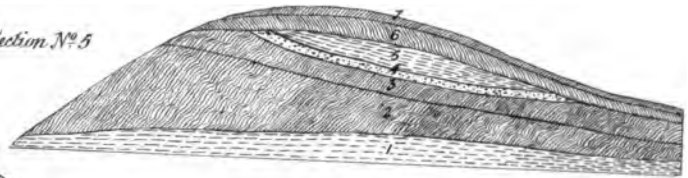
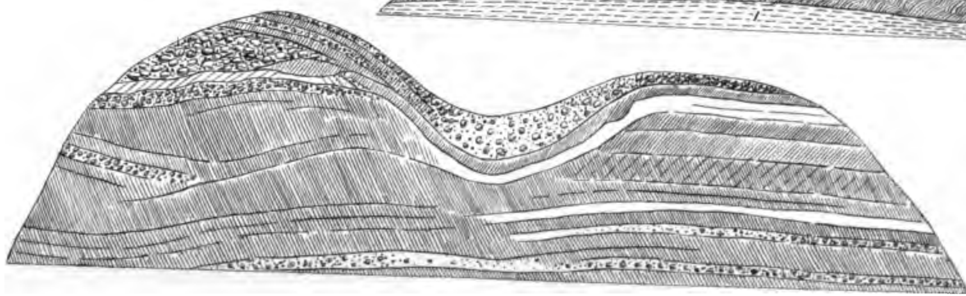
Section No. 6



Section No. 5





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In cross-sections of the escars it is easily seen that the sandy beds generally agree, more or less, with the curved outline of the hills; but

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this is not always the case, as may be well observed at Cloonascragh, near Tuam, where the gravel hill is evidently the remaining portion of a more extensive deposit. Here also may be remarked the tendency of the larger gravel and boulders to congregate towards the top,—a phenomenon of common occurrence, which I attempted to explain in my former paper (see Section 4, also 2 and 3).

I have latterly paid much attention to the striation of rock surfaces beneath the drift. The grooved markings on the polished rock run uniformly over a large area, in straight lines, parallel with the general course of the escar-hill chains, and, like them, irrespective of the hypsimetrical outlines of the country. This fact, together with the circumstance of stratified drift lying above them, precludes the notion of ascribing them to land ice subsequent to the last emergence; and, as stated in my former paper, I believe that weighty objections exist against the hypothesis that attributes them to grounding icebergs. I explained how I thought that the parallelism of the engraved lines over a considerable district was unfavourable to that idea, as the motion of an iceberg touching ground would probably be curvilinear and irregular; and it also appears to me that any scorings of icebergs would be effaced by the rubbings of the drift which subsequently covered them.

In my former paper, while advocating the aqueous theory of the drift, I did not deny the probability of a glacial climate having existed here at a comparatively recent period; but argued that at least the present condition of the drift is not to be referred to its effects; and, believing that the striated appearance of the surface rocks of my district could not result from the action of land glaciers or floating icebergs, I asked whether it might not have been caused by the rubbing of large flat masses of rock while pushed along by the waves before they became sufficiently rounded to roll. At the same time, I must say, that from the great resemblance of the striæ to glacier markings, I would rather, if possible, refer them to the operations of ice in some shape. The idea of ice formed at the bottom of the sea did not occur to me at the time; but I now believe that this affords the best solution of the case, and that it is most probably by means of *ground ice* the lines were cut into the rock surfaces, and afterwards preserved from the obliterating friction of superposed drift. Sheets of ground ice, when detached from the bottom, might be prevented from floating by the weight of adhering rocks, and, driven along by the currents, would act as submarine glaciers in the production of the scorings. Drift deposits might accumulate on them, and would tranquilly settle down on the striated rock when the ice melted away. In this manner we might explain the straight striation of rock surfaces over a large area, the formation of frequently stratified drift above, and the preservation of the striæ,—a set of phenomena which, I conceive, no other glacial hypothesis can well account for.

It is, indeed, probable that the south-western currents brought no icebergs, properly so called, from distant localities; and during the immersion of the great central plains of Ireland there must have been but few elevated valleys where glaciers could form, and, reaching the sea, could give rise to icebergs,—at least there have been no *moraines* left

behind to mark the beds of glaciers among our mountains, and it is likely that the glacial conditions of climate gradually disappeared as the land emerged from the ocean. Even in Snowdonia, the classic land of British glacialism, I failed to discover any unmistakable development of moraines, though in some places heaps of drift or detritus were to be observed; and I saw the polished and grooved rocks the same as in the low country in my own district. But whatever real evidences of glacial action may remain, I am still of opinion that the principal accumulations of the drift, not alone in my district, but wherever I examined them in Ireland and England, are of aqueous origin, while they betray sedimentary arrangement or otherwise, according to the character of their materials.

The drift of the Yorkshire coast is well known. It is composed in a great measure of tenacious clay, which is not stratified; but above the amorphous mass, below it, or within it, are often found regular beds of sand or fine gravel, which prove the action of stratifying causes during its deposition (see Sections 5 and 6).

In my former paper I stated my opinions regarding the ascent of hills by large boulders, and remarked that Mr. Darwin had already written on the subject; but, not having seen his paper, I could not say how far his ideas might agree with or differ from mine, which were, that the blocks were driven up the hills by the breakers during a sinking of the land. I have since been informed of Mr. Darwin's views; and it appears that they coincided with mine regarding the *submergence*, which was the main point of the hypothesis; but he considered icebergs, and not breakers, as the agents in the transfer of the blocks. This notion of subsidence obliged me to separate our drifts as the formations of different periods; but by admitting the action of ground ice, the hypothesis of the *land sinking* becomes unnecessary to account for the carrying of boulders up the sides of acclivities; and our entire drift, together with the rock-markings, may be referred to a single period during the last *elevation* of the land. While some portions of the ground ice, as already remarked, might be too heavily laden to rise to the surface when disengaged from the bottom, others might have sufficient buoyancy to float up with their attached rocks, which might thus be transferred to higher levels at the time of the emergence. Pieces of this floating ground ice and ice formed on the coasts might act as icebergs, even in the general distribution of erratics, but with modified results; for they could neither be the bearers of the great load of detritus which the true iceberg carries away from crumbling mountains, nor would they be likely to transport large fragments of rock to such considerable distances as are attained by those that ride on the sea-borne glacier. The larger of the blocks that they carried, frozen into their under surface, would first fall out during the progress of their melting, and in collisions with each other; and we could thus account on glacial principles for the decrease in size of our erratics, according to their distance from their sources; while we could also comprehend why we never find blocks of considerable dimensions far removed from their native localities. Both these facts I considered adverse to the glacial theory, as I stated in my former paper; and I still

regard them as proofs that the conveyance of the travelled rocks of my district was not due to ordinary icebergs.

I also noticed the difficulty of separating the "clay drift" from the escar formation, both of which, I said, might be easily considered as identical, and overlaid by the "boulder drift." The ground-ice hypothesis now inclines me to regard them as truly identical and contemporaneous with the latter, though differing from it in character and direction. The escar drift was aqueous, and came from the south-west; but the boulders from the west or north-west were, most probably, removed by the floating ground-ice, which would not be altogether under the influence of the currents, but would also be affected by the winds. Though the small proportion of the ice above water would generally give a preponderance to the power of the current, which would carry it nearly in its own direction, still, during storms, or during temporary changes in the course, or lateral boundaries of the current itself, the ice might be sent across the ordinary path of the moving waters. The appearance of boulders from the W. or N. W. on the surface of the south-western drift of the Barna and Aughinish cliffs may, perhaps, be understood by this conjecture; and the absence of similar blocks in the underlying mass would merely show that, during the deposition of its materials, the current did not permit the approach of floating ice from westerly or northerly points. The distinction here and elsewhere between the boulders and the subjacent drift impelled me at first to refer them to separate periods of deposition, assuming the "*boulder drift*" from about the north-west as overlying the "*clay drift*" of the cliffs; while a third drift was suggested by the escar hill-chains, whose uneffaced forms obliged me to regard the south-westerly currents that formed them as the last that passed over the district. However, if in the way that I have here attempted to explain, the entire drift can be understood as the product of a single period during the prevalence of one great current, subject, of course, to local deviations and temporary changes from various causes, we shall get a theory more simple than the other, and one, therefore, to be preferred.

By admitting that ground-ice might be capable of removing matter to higher positions, we avoid the necessity of referring portions of our drift to a time when the land descended through the waves, and we escape the rather difficult supposition that a former Ireland, with the orographical features of the present, existed above the ocean, and became engulfed during a comparatively short period. Still we cannot be sure that it was not so, and that the land at its reappearance did not present the same forms of hill and valley: yet it strikes me that this hypothesis, which before appeared indispensable in accounting for the hill-ascending drift, may be advantageously replaced by the more simple one of attributing to ground-ice the power of action that I suggest, whereby the various phenomena ascribed to different periods of subsidence and elevation may be reduced to the limits of a single era, as the rising land approached the surface of the sea. However, if the hypothesis that blocks were raised to higher levels during a sinking of the land be preferred, then the idea of the separate drift periods, as set forth in my first paper, seems unavoidable.

MR. J. BEETE JUKES read a paper by MR. FREDERICK J. FOOT—

NOTICE OF SOME NEW LOCALITIES FOR POSIDONOMYA NEAR ENNIS, COUNTY OF CLARE.

THE object of the present notice is to add some localities where Posidonomya occur (with specimens exhibiting both valves) to those mentioned by Sir Richard Griffith in his paper of the 14th of April, 1858.

These localities are in the neighbourhood of Ennis, county of Clare, the beds in which the fossils were found being the basal shales of the coal-measure series.

These shales are best developed in an old road-cutting through the townland of Rosscliff, about a quarter of a mile S. E. of the village of Ballynacally, and ten miles south of Ennis. They dip to the N. W. at from 40° to 80°. The section in this cutting affords a thickness of 250 feet.

It is impossible to say what is the exact thickness of shales from the top bed of the limestone to the first grit bed of the coal-measures, as the section from the former to the latter is not continuous. There must be at least 800 feet. The uppermost bed of the limestone visible is a pale-gray marble, and the nearest beds above this are black, flaggy shales, with chert layers. As we ascend in the series, the chert disappears, and we have black flaggy shales, easily split in the planes of lamination, and abounding in Posidonomya, several specimens of which show both valves.

On being split, some of the shales present a surface literally covered with Posidonomya. They are associated with several other fossils, among which are a few plants.

[NOTE BY MR. W. H. BAILY.—"The following is a list of fossils from this locality collected by Mr. Foot:—

"A few stems of plants (Goniatites), and what appears to be a fish-scale.

Posidonomya Becheri, or *lateralis*; probably one species.

Aviculopecten papyraceus; characteristic of lower coal-shales.

Lunulacardium Footii (*n. s.*); a new species of cardioid shell."

Mr. Kelly informs me that he collected this species at Cahernanalt, Keadue, county of Roscommon, from what he calls the millstone grit, and that it is in Sir R. Griffith's collection. The specimen which I have seen may possibly be of the same species; however, it is much smaller, and has fewer ribs than the one collected by Mr. Foot. As both are undescribed, I have named it after Mr. Foot.

The generic name of Lunulacardium, Mr. Byron informs me, was given to the fossil in Sir R. Griffith's collection by Mr. Salter. This name I have retained, although it is not, I believe, a published one.]

The next place where these shales are seen is about two miles S.W. of Ennis, in the bed of the Inch, or Claureen River, near Coor Spa-well.

Here the topmost beds of the limestone form a synclinal fold, in which the shales lie. They abound in Posidonomya, and both valves are seen in some specimens.

[NOTE BY MR. BAILY.—"Several other fossils are also found here, of which the following were collected by Mr. Foot:—

"*Posidonomya lateralis*, or *Becheri*.
Aviculopecten papyraceus.
Goniatites crenistria.
,, *Gibsoni* (and probably *rotiformis*).
,, *striatus?*
,, *reticulatus*.
Orthoceras."]

At about four miles N.W. of Ennis, in the townland of Ballynabinnia, are two localities: one is at the south side of the townland, in the bed of the stream, where there is a well-exposed junction between the limestone and coal-measures. Here, indeed, the Posidonomya are not very plentiful, but Goniatites and other fossils are abundant.

At the north side of the townland, however, and at the south side of the road leading from Ennis to Ennistimon, in a small stream, the shales, on being split, appear covered with Posidonomya, which in some cases have both valves.

I have not yet examined the country north of this.

[NOTE BY MR. BAILY.—"Fossils collected at Ballynabinnia by Mr. Foot:—

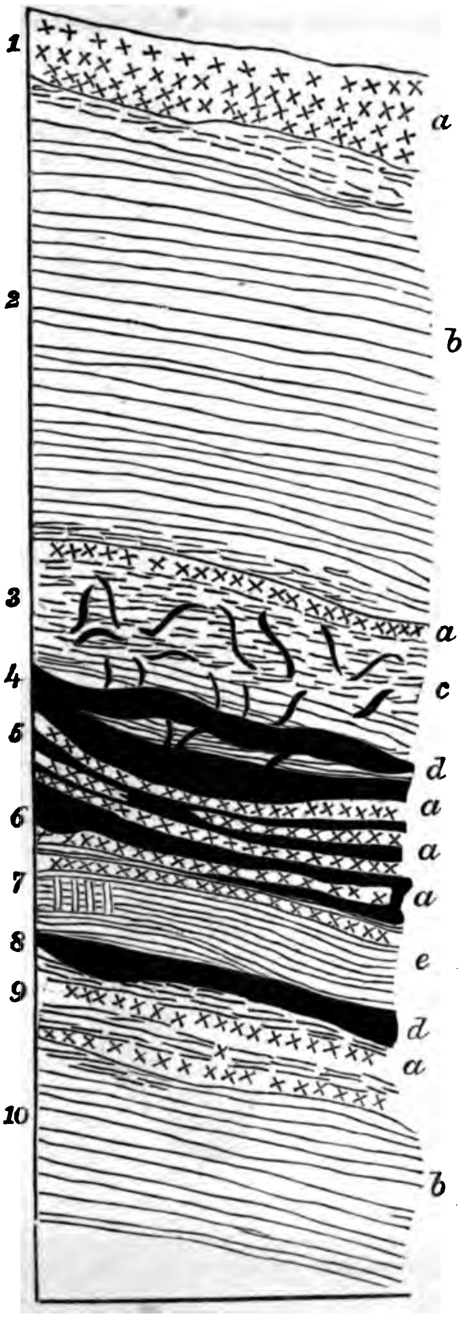
"Cast of Athyris?
Chonetes sordida.
Posidonomya Becheri and *lateralis*.
Euomphalus.
Goniatites crenistria, and smooth species (probably Villyer?)
Cypridina?"]

PROFESSOR J. R. KINAHAN, M. D., F. L. S., &c., read a paper—

ON HAUGHTONIA (KINAHAN), A NEW GENUS OF CAMBRIAN FOSSILS FROM BRAY HEAD, COUNTY OF WICKLOW.

HAPPENING last June to be examining the series of Cambrian beds near the "Periwinkle Rocks," on the N.E. side of Howth, of which the accompanying section is copied by permission from the "Transactions of the Royal Irish Academy;"* my attention was attracted by a peculiar mottling of the upper surface of the red grit-bed, marked 7 E in the series.

* "The Genus Oldhamia: its Characters, probable Affinities, Modes of Occurrence; and a Description of the Nature of the Localities in which it occurs."—*Trans. R. I. A.*, *Science*, vol. xxiii. The accompanying Engraving exhibits vertical section of rock in neighbourhood of Periwinkle Rocks, Bray Head, showing general relations, and lie of the fossiliferous strata. These beds are much distorted.



EXPLANATION OF SECTION.

1. Greenish-gray bed of closely compressed *Oldhamia radiata*, 12 in. thick.

2. Green compact quartzose grit, underlying greenish-gray schist, on which it also rests; 7 ft. 7 in. thick.

3. Thin layer of *Oldhamia radiata*, badly marked, lying on green and red schists, which are interspersed with vertical and horizontal Arenicolites, and gradually pass into red grit; from 18 in. to 2 ft. 6 in. thick.

4. Red shale; fine red micaceous gritty slate; compact red shale; 9 inches thick.

5. *Oldhamia radiata* in series of beds from 0·25 inch to 3 inches, interstratified with compact red shale; series of beds 15 to 24 inches thick.

6. *Oldhamia radiata*, in thin beds, interstratified with red shale and green grit; 12 inches thick.

7. Compact red grit, with traces resembling coral; 15 inches thick.

8. Compact red shale; 6 inches thick.

9. Red schist and *Oldhamia radiata*, in beds, passing into red grit; scattered fans of *Oldhamia antiqua* also rarely occur here; 15 inches thick.

10. Grit, similar to No. 2.

a Oldhamia beds.

c Schist and slates.

b Quartzose grit beds.

d Shales.

e Coralloid traces.

This mottling, on closer examination, was found to be caused by a number of irregularly rounded, whitish spots, most of them 0·1 inch in diameter, separated from one another by red interspaces, and presenting the appearances usually presented in a cross section of a series of tubes aggregated together. The vertical section of the bed exhibited, in the weathered parts of it, narrow white streaks, 0·1 inch in width, preserving pretty nearly the same direction, but yet neither perfectly parallel, nor the streaks strictly continuous in their entire length. At the upper part of the bed many of these were traceable into the white dots, with which, as already stated, they agree strictly in transverse dimension. These lines, when not strictly continuous, were found to be made up of a series of somewhat spindle-shaped spaces, rounded at one end, and slightly narrower at the other,—in short, exactly the same section as might be expected in a series of conglomerated tortuous tubes: such a section, in fact, as this specimen of agglutinated clay-tubes of one of the fresh-water worms affords (Fig. 1).

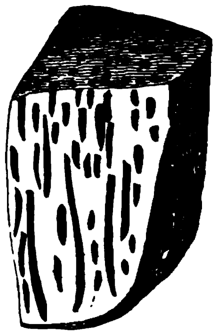


Fig. 1
Section of mass of tubes of fresh-water Annelids. Recent.

These appearances were only presented by a limited extent of the bed in the first locality in which I met it, being restricted to a space about six inches in breadth, and probably ten in width. The vertical depth of the markings is about five inches.

The characteristic appearances are only seen on the well-weathered portions of the beds; but a new fracture, on careful examination, exhibits them; in this case the white spots and lines are seen to be greenish; they also preserve the same relative characters according as the fracture is longitudinal or transverse. Polishing the surface fails to make them more evident, as it then requires a careful management of the light to make out the markings; but the structure of the longitudinal section is best seen in the polished specimens (Fig. 2).

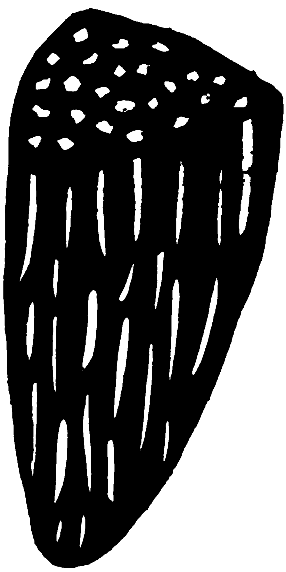


Fig. 2.
Haughtonia poecila.—Section.

The constancy in form of these appearances, their limitation to a particular part of the bed, their universal diffusion in that part of the bed, and their coincidence in character with the aggregated masses of worm-tubes alluded to, are, I conceive, sufficient evidence of their organic origin. The absence

are, I conceive, sufficient evidence of their organic origin. The absence of any trace of structure, either radiating plates internally, or connecting plates externally, causes the rejection of the supposition that these are traces of a badly preserved coral, to the sections of certain forms of which, such as Cyathophyllum and Calamophyllia, they bear at first sight no slight resemblance.

If we suppose them, however, to be the traces of a mass of gregarious tubicolous worms, inhabiting tubes aggregated together, the tubes formed by the worms cementing the surrounding sand with a peculiar mucous secretion, in short, such a tube as exists singly in the case of the Common Gold-comb, and in a compact mass of many interlacing, tortuous tubuli in certain species of Sabella, which are extremely common, forming compact masses in the sand, and encrusting the rocks in the extreme littoral and laminarian zones of the present day, the difficulties we find in demonstrating the fossil are at once explained, as such a colony, if fossilized, would have their tubuli gradually filled up with fine sand in proportion as the animal decayed, or else subsequently; and the difference in colour of the sand contained within the tube and of the sand in which the tubuli are embedded is to be referred to the well-known action of the organic matter on the former, and the worms, being soft, would leave no traces of their organs. It is, then, most probable that these fossils belonged formerly to worms of this kind, and that the whole mass represents a colony of these tubuli embedded in a sandy beach, represented now by the red, gritty bed.

No fossils of a similar kind having been described, I would propose for this genus the name *Haughtonia*, after our respected President, by whom I was accompanied on the day of its discovery, adding, as a trivial name, that of *Pœcila*, in allusion to the regularly variegated appearance communicated by it to the rock mass in which it is found. The characters of the genus are chiefly drawn from the supposed habits of the worms, as no points of their structure or form can be now made out.

Haughtonia (*n. g.*).

Tuberculous worms, gregarious, occurring in a mass; tubes somewhat tortuous, matted together, formed of sand particles, agglutinated by an organic basis.

Sp. una.

H. pœcila (ποικιλος).

Tubuli somewhat rounded in outline.

Diameter, 0·1 inch.

Locality: Red gritty beds, Periwinkle Rocks, Bray Head, county of Wicklow.

Formation: Cambrian.

The curious fact of the prevailing forms amongst these Cambrian fossils being annellidan, alluded to by Mr. Salter in the case of the Longmynd rocks, receives fresh confirmation by the discovery of this form, Although no fossil similar to this has been hitherto described, it is by no means certain that none have been discovered, as mere fossilists, ac-

customed to the well-marked organic remains of the other systems, are too apt to pass over annellidan, and such like traces, without sufficient study, especially when, as in this case, it requires a combination of favouring circumstances, such as light, &c., to demonstrate the nature of the fossil satisfactorily, and even then, without the advantage of a comparison of it with recent forms, its true nature must remain in doubt.

Some palæontologists will possibly question the propriety of affixing a name to a fossil so difficult of establishment, but every zoologist will understand the necessity of recording every organic trace, no matter how difficult of demonstration, which tends to throw a light on the habits of the animals which lived in so early a period of the world's history as the Cambrian.

WILLIAM H. BAILY, F. G. S., read a paper—

ON FOSSIL LOCALITIES NEAR DROGHEDA.

DURING some recent visits to Drogheda I availed myself of the opportunity to examine the most important of the fossil localities in that neighbourhood, the results of which I now communicate to the Society. Before doing so, however, I would beg leave to express my obligations to Mr. William Williams, of Drogheda, who by his local knowledge of the geology of the district, and so liberally placing his fine collection of Carboniferous Limestone fossils at my disposal, greatly facilitated these investigations.

The diagrammatic section (Pl. IV., Fig. 1) to which I shall first have to call your attention is mostly constructed from the six-inch Map, the Geology on which being laid down by Sir Richard Griffith.* It commences at the Maiden Tower, Drogheda Bay, running nearly in the direction of the River Boyne, through the Carboniferous Slate or Lower Limestone shale, near Mornington, the Lower Limestone at Donore Hill, Lower Calp shale, Sandstone, and Upper Calp shale, at Stalleen and Newgrange House. It again passes through the Sandstone and Lower Calp shale at Rosmaree, forming a basin in the Lower Limestone, through which the section continues to beyond Slane, where it passes through a protruded mass of greenstone, and enters the Lower Silurian at Rushwee, a distance of about fourteen miles.†

Commencing from the sea, the banks of the River Boyne exhibit a section of gravel and sand, the gravel being cemented in some places by carbonate of lime. The rock, however, does not appear further east than Stameen Quarry, which is half-way between Drogheda and Mornington. East of Stameen Quarry the beds on each side of the Boyne dip towards each other, forming a synclinal axis. Detached boulders and large pebbles from the drift, with their surfaces scratched, scored, and grooved, may be seen strewed over what is called Buck's Meadow, close to the Viaduct, on the north side of the Boyne. Several of the larger rolled

* To whom I am indebted for the loan of them.

† These stratigraphical divisions are those of Sir R. Griffith. See note on p. 24.

fragments are clearly seen to be not only grooved and striated lengthwise, but across, and in an angular direction, indicating a shifting of their position during the transit to which they were subjected. Mr. Williams, who first pointed them out to me, conjectures the direction in which they travelled to have been very nearly directly west, in a line from Galway Bay, for in some cases the surface of the rock over which drift deposit may have passed exhibits corresponding markings caused by the friction produced on their passage.

The fragments, some of which are of large size, are of rounded and angular forms, consisting mostly of Carboniferous Limestone, with Calp shale and sandstone, and Silurian, also compact greenstone, but few granite pebbles,—this drift being, as is usually the case, mostly composed of fragments of the subjacent rocks, although some may have travelled a long distance.

The Lower Limestone shale does not appear further east than Stameen, one mile from Drogheda, and half-way between it and Mornington.

The large quarry belonging to the Boyne Commissioners, called Stameen, and close to the River Boyne, is an acre square, and 100 feet at its deepest part. The drift overlies it to the depth of about 14 feet, the beds of black Carbonaceous Limestone,[1] with shale partings, dip at an angle of 15° or 20°, and are from 1 foot to 3 feet 7 inches in thickness, very large surfaces being exposed, and the blocks of stone obtained are often of large size. A singular mineral substance was obtained from between the joints, resembling mountain leather; it occurs in large white flakes, which were quite flexible when first found. My friend, M. Gages, has promised to examine this remarkable substance, the result of which he will, I trust, bring before the Society. On the extensive surface of a bed exposed at the lower part of the quarry, many large corals (*Zaphrentis cylindrica*) were observed. In most of the fossils, particularly the chambered shells, the substance of the shell is converted into a brilliant iron pyrites.

The following species were obtained:—

Zaphrentis cylindrica.*
Actinocrinus (stems).*
Spirifera striata, S. glabra, and S. pinguis.
Terebratula sacculus.
Producta undata.
Loxonema tumida?
Bellerophon.
Nautilus (Discites) costellatus.
Orthoceras undulatum ?
Goniatites.

At another quarry, belonging to William Cairnes, Esq., in the same townland, near the Dublin and Belfast Railway, are laminated and earthy shales, dividing into extremely thin and numerous partings; a single specimen (*Goniatites crenistria ?*) was the only fossil I obtained from them.

[1] See notice by M. Gages on the composition of these earthy limestones, p. 125 of this Journal.

* The asterisks indicate the abundance of the species.

Underneath these shales is a black crinoidal limestone, with layers of chert. The fossils collected from the limestone in this quarry were—

Actinocrinus (stems).*
Fenestella ejuncida and F. undulata.
Orthis resupinata.
Spirifera glabra and S. lineata.
Strophalosia striata.
Strophomena analoga.
Producta carbonaria and granulata.
Cypridina primæva ?

From the debris of an extensive quarry, now filled with water, close to the Boyne Viaduct, on the south side of the river, and which furnished the stone used in the construction of that elegant work, was obtained a large block of conglomerate, passing into a sandy limestone, the pebbles in which range from about 1¼ inches to ¼ of an inch, being mostly derived from Silurian rocks. The surface shows amongst the embedded fragments small honeycomb corals, *Lithostrotion Portlocki*, with a fine fish palate, *Cochliodus* (?), both carboniferous limestone fossils; dark arenaceous rocks, with tracks, ripple-marks, and other bodies which may possibly be coprolitic; and black shales, very similar to those of the coal-measures, containing remains of plants, are abundant.

In the immediate vicinity of the town of Drogheda, and for some distance round it, the Lower Limestone of Sir R. Griffith is the surface rock: it consists of gray and light-blue crystalline limestone. At Ball's Grove, S.W. of Drogheda, and immediately outside the town, it is a dark-gray crystalline and splintery limestone, with joints and stems of Actinocrinus, but few other fossils. The beds dip at about 15°. At this quarry the great depth of drift covering the limestone may be observed, it being here upwards of 30 feet in thickness.

The site of the Boyne Obelisk is well selected, its foundation being a natural boss of limestone, dipping S. S. W., at an angle of 20°. Bands of chert traverse it in the direction of the bedding, though containing but few fossils, excepting Crinoids, the surface of the beds in the immediate neighbourhood exhibiting a mass of their stems.

At Heeney's Quarry, Mell, on the Slane road, towards Drogheda, is a bluish crinoidal limestone, very crystalline, and traversed by numerous joints. The upper beds are cherty, and full of crinoid stems; the surface of some of the beds are also covered by the large stems of a species of Actinocrinus.

At Cruicerath is a boss of limestone, occupying an elevated position, at a height of 270 feet above the sea, the surface being much broken up. Some of the beds are full of fossils, in fine preservation. Collections made by Mr. Williams and Mr. Leonard from this locality contain more than 50 species, among which are several new forms, *Terebratula hastata*, which is very abundant in these beds, being often found with the radiating bands of colour still preserved, as noticed by Professor Haughton in the Society's Journal, vol. vi., part 1.

The following species have been determined from this locality :—

Zoophyta.

Zaphrentis cylindrica.	Lithodendron affine.

Brachiopoda.

Producta gigantea.*	Strophalosia striata.
,, aurita.	Terebratula hastata.**
,, costata.	,, sacculus.*
,, cora.	Strophomena crenistria.
,, Scotica.	,, analoga.
,, rugata.	Chonetes papilionacea.
,, Martini.*	Spirifera pinguis.**
,, semi-reticulata.*	,, globularis.
,, fimbriata.	,, attenuata.
,, punctata.	,, glabra.
,, mesaloba.	,, convoluta.
,, plicatilis.	Rhynchonella pleurodon.
,, flexistria.	Orthis resupinata.**

Conchifera.

Aviculopecten concavus.	Cardiomorpha oblonga.
,, plicatilis.	,, elongata.
,, Dumontianus.	Conocardium minax.
Modiola elongata ?	,, rostratum.

Cucullæa tenuistriata.

Gasteropoda.

Fusus primordialis, De Kon.	Pleurotomaria conica.
Natica ampliata.	Euomphalus Dionysii.
Pleurotomaria carinata.	Bellerophon hiulcus.

Cephalopoda.

Orthoceras Martineanum.	Orthoceras Gesneri.
,, undulatum.	Nautilus discus.

Crustacea.

Phillipsia pustulata.	Griffithides globiceps.

Close to this extremely fossiliferous locality, at a small quarry, in a field on the opposite side of the road, is a decomposing limestone, which is one mass of large crinoid stems (Actinocrinus).

Mr. Williams called my attention to a difference in the colour of the limestones of this neighbourhood: they appear to pass upwards by a series of gradations from the earthy black limestone, such as that at Stalleen,

* The asterisks indicate the abundance of the species.

to the gray crinoidal limestone of Sheephouse Quarry, which is very durable, and much used for building purposes.

From the Upper Calp shale of Sir R. Griffith, on the south bank of the Boyne River, near Donore, in brownish earthy shales easily separating into thin layers, was obtained small *Posidonomya membranacea* (M'Coy), (probably the young of *P. Becheri* or *lateralis*), and *Goniatites Gibsoni* and *crenistrius*. This shale, with its contents, is almost undistinguishable from those found by Mr. Foot in the basal beds of the coal-measures, county of Clare. In a wood near the same locality, at a waterfall, the junction of the Upper Calp shale and sandstone is well shown, the shales at the junction being very black and gritty. The beds of sandstone have a thickness of from seven inches to a foot, with sandy shale partings, and may be observed to a depth of about 13 feet. From the shales was obtained a fish-scale, identical in form to one recently collected by me from the basal beds of the coal-measures at Rosscliff, county of Clare. They appeared otherwise very bare of fossils. These shales and sandstones bear a considerable resemblance to those of the coal-measures.* A fragment of an uncompressed Calamite and Knorria was obtained from what Sir R. Griffith calls the calp sandstone, on the opposite shore.

The Lower Silurian beds, near Drogheda, are mostly unfossiliferous; they may be well seen at King William's Glen, near the Obelisk, where they exhibit contorted and highly inclined beds of greenish flags and indurated clays with quartzose grits.

At the Commons of Slane, in a small quarry near the Ardee road, are black shales, some of which are indurated and cherty. From these shales, which readily separate into laminæ, were obtained *Diplograpsus teretriusculus* and *pristis*, with a small species of Discina; near this, at a place marked on the map as "coal-pits," we found an old shaft, now filled with water, which had been sunk through the shales in a fruitless search for coal.

A fine section of these extraordinary black shales is exposed at the cross roads of Glenallen. The beds are mostly vertical, much twisted, contorted, and broken up. The Graptolites are not easily found here, the shales being mostly of a hard and cherty nature, which do not readily split into laminæ. I succeeded, however, in finding the same species as at the Commons of Slane.

At Grangegeth, in a quarry close to the road between the Cross of Grange and Newtown Fortescue, are some very fossiliferous beds in the Lower Silurian, the whole surface being, where decomposed, nearly covered with Brachiopod shells, principallly *Orthis calligramma*. The stone, when not decomposed, is an exceedingly hard and tough limestone.

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* This conjecture has been since confirmed by Mr. Jukes, by his determination that corresponding strata in the townland of Westown, near Naul, county of Dublin, are Coal-measures. I collected fossils at that place, some of them identical with those found in the shales on the south bank of the Boyne, viz., the *Aviculopecten variabilis* and *Posidonomya membranacea*, associated with the characteristic coal-measure species, *Aviculopecten papyraceus*, &c.

2

2a

2b

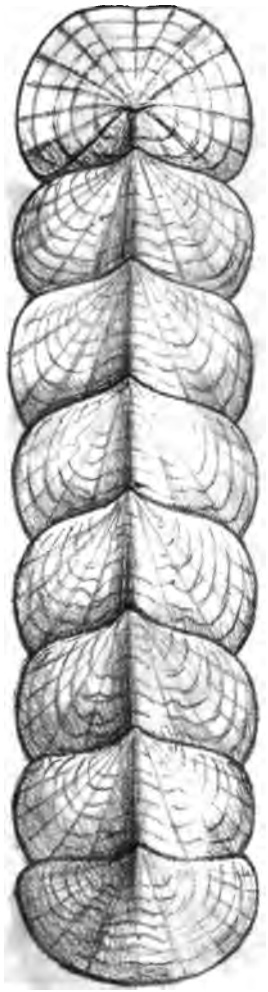

Fig 2 c.

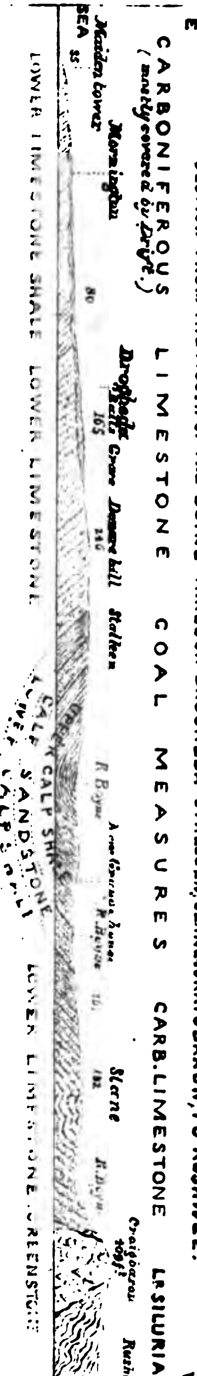

Fig. 1

Horizontal scale ½ an inch to a mile Vertical scale 3 inches to a mile.

W. H. Baily del. et lith.

The following are the fossils from this locality, which appear to be equivalent with those from the Bala beds:—

Echinodermata.

Caryocystites Davisii.

Conchifera.

Conocardium pristie.

Brachiopoda.

Orthis virgata.	Orthis elegantula.
,, flabellulum.	,, calligramma.
,, biforata.	Strophomena complanata.
,, Hirnantensis.	,, concentrica.

Strophomena corrugata.

Crustacea.

Illænus Bowmanni.	Lichas Hibernicus.
Cybele verrucosa.	,, laxatus.

Above this quarry a mass of protruded greenstone forms a rising ground, its greatest height being 660 feet above the sea; portions of this greenstone appear in the road, which is nearly its boundary; it is again crossed on the road from Newtown Fortescue to the Cullen road.

There are several other protrusions of this igneous rock through the Lower Silurians of this part of the country.

Alphonse Gages, M. R. I. A., read the following paper:—

NOTICE OF DROGHEDA LOWER LIMESTONE SHALE.

The Lower Limestone shale from Stameen, near Drogheda, judging from the specimen I got from my friend, Mr. Baily, is a black, earthy, compact, calcareous rock, sometimes crystalline, and having small crystals of iron pyrites disseminated through the mass. The presence of these crystals, in many instances so uniformly spread through it, may be accounted for by the reducing action of organic matter existing in the mud on the sulphates, especially on the sulphate of lime held in solution by the water. The resulting sulphurets produced during the slow process of decay of this organic matter reacting on the salts of iron (uniformly present under such circumstances) must necessarily transform them into sulphuret of iron.

A similar process of decomposition may be observed whenever the old pavement of a street is removed; especially where it had rested upon a retentive soil, the mud under it will be of a blackish colour, and the smell of sulphuretted hydrogen will serve to indicate the process of decomposition going on.

A fragment of the Lower Limestone shale, mentioned above, treated with hydrochloric acid, leaves, after removal of the lime, a residue analogous to that of the shale found in the Calp or Middle Limestone of Sir R. Griffith. After this operation, it could be employed for tracing black lines,

and for other purposes of graphic shale. I merely wish by this observation to direct the attention of Irish geologists to the analogy existing between these two substances. The quantity of carbon, in both cases, sufficient to communicate the graphic properties to the clay mud, does not exceed in many instances $\frac{1}{4}$th per cent.

This shale of the lower limestone leaves, after treatment by acids and combustion, a residue of clay resembling the clay left after the calcination of the graphic shale of the middle limestone: these residues differing only by small proportions of sand.

The residue left, after similar treatment of the calp limestone, belongs to the same class, and, although I have not devoted much attention to the latter, I have thought the analogy which these different shales present in their mode of formation a point worthy of attention.

ANNUAL GENERAL MEETING, FEBRUARY 9, 1859.

THE Society having met at 2 o'clock,

DR. DAVIS, and afterwards the PRESIDENT, was moved to the Chair.

The President nominated Mr. Jukes and Dr. Kinahan as Scrutineers.
The following Report from Council was submitted and adopted:—

REPORT.

THE Council wish, in the first place, to record their satisfaction at the healthy state of the Society, both with regard to the number of its Members, and the nature of the work done.

The number of Members is indeed a little reduced, being only 146 this year, as compared with 155 last year. This loss of nine, however, is partly an apparent one only, as seven names were retained last year of Members whose subscriptions were in arrear, which names are now omitted from our books.

The present state of the finances of the Society is also satisfactory, inasmuch as a small balance of £16 4*s*. 9*d*. remains after defraying all the expenses of the past year. In addition to this, a sum of £30, received for Life Compositions, has been added to the stock standing in the name of the Trustees of the Society, which now amounts to £80. This, however, was possible only in consequence of the balance of £71 14*s*. 8*d*. brought forward from the year 1857, of which £55 was for Life Compositions, so that the present stock scarcely represents the Life Compositions of the two past years.

The Council would be glad if they were able to state that the income derived from their funded stock was large enough to be equivalent to the annual subscriptions of the existing Life Members,—a condition they hope that the funds of the Society will eventually attain to.

Among the names of Members deceased your Council deeply regret to have to record that of Professor Robert Harrison, M. D., a gentleman distinguished by his scientific attainments in Anatomy and Physiology, who never omitted in his lectures, or elsewhere, to point out and explain

the important and essential accessions to the knowledge of those subjects afforded by Palæontology.

In the Appendix will be found—1st, the names and addresses of the Members now on the books of the Society; 2nd, the list of Societies and Institutions entitled to receive the Journal of the Society; 3rd, the list of the Members lost and gained during the past year; 4th, the list of the Donations received during the year 1858; 5th, abstract of the Treasurer's account.

APPENDIX TO ANNUAL REPORT.

No. I.

LIST OF MEMBERS, CORRECTED TO JANUARY 31, 1859.

Members are requested to correct errors in this List, by letter to the REV. SAMUEL HAUGHTON, *Trinity College, Dublin.*

HONORARY MEMBERS.

Elected.
1844. 1. Boué, Amie, F. G. S., *Paris.*
1844. 2. Lyell, Sir Charles, F. R. S., 11, *Harley-street, London.*
1844. 3. Murchison, Sir Roderick J., G. C. St. G., F. R. S., H. M. R. I. A., 16, *Belgrave-square, London.*
1832. 4. Sedgwick, Rev. A., M. A., F. R. S., *Cambridge.*

HONORARY CORRESPONDING MEMBERS.

1854. 1. Thomas Oldham, F. R. S., *India.*
1854. 2. Arthur A. Jacob, C. E., *India.*
1855. 3. Joseph Medlicott, *India.*

MEMBERS WHO HAVE PAID LIFE COMPOSITION.

1858. 1. Allen, Richard Purdy, *Austin Friars, London.*
1857. 2. Carson, Rev. Joseph, D. D., *Trinity College.*
1832. 3. Davis, Charles, M. D., M. R. I. A., 83, *York-street.*
1857. 4. Green, John Ball, 6, *Ely-place.*
1857. 5. Haliday, A. H., A. M., F. L. S., M. R. I. A., *Harcourt-street.*
1831. 6. Hamilton, Sir W. R., M. R. I. A., *Observatory, Dunsink.*
1848. 7. Haughton, Rev. Professor, F. G. S., 40, *Trinity College.*
1850. 8. Hone, Nathaniel, M. R. I. A., *St. Doulough's, Co. Dublin.*
1831. 9. Hutton, Robert, M. R. I. A., F. G. S., *Putney Park, London.*
1851. 10. Jukes, Joseph Beete, A. M., F. R. S., M. R. I. A., 51, *Stephen's-green.*
1834. 11. King, Hon. James, M. R. I. A., *Mitchelstown.*
1844. 12. King, John, *Dame-street.*
1856. 13. Lentaigne, John, M. D., *Great Denmark-street.*
1848. 14. Luby, Rev. Thomas, D. D., M. R. I. A., *Trinity College.*
1851. 15. Malahide, Lord Talbot de, F. R. S., *Malahide Court, Malahide.*
1838. 16. Mallet, Robert, C. E., M. R. I. A., F. G. S., *Delville, Glasnevin,* and 11, *Bridge-street, Westminster, London, S. W.*
1846. 17. Murray, B. B., 69, *Lower Gardiner-street.*
1859. 18. Ogilby, William, *Liscleen, Dunmanagh, Co. Tyrone.*
1851. 19. Whitty, John Irvine, LL. D., *Henrietta-street.*

MEMBERS WHO HAVE PAID HALF LIFE COMPOSITION.

1831. 1. Baillie, Rev. James Kennedy, D. D., M. R. I. A., *Ardtrea, Stewartstown.*
1854. 2. Barnes, Edward, *Ballymurtagh, Co. Wicklow.*
1832. 3. Bryce, James, *High School, Glasgow.*
1854. 4. Clemes, John, *Luganure Mine, Glendalough, Co. Wicklow.*
1855. 5. Carter, Sampson, C. E., *Kilkenny.*
1857. 6. Crawford, Robert, *care of Messrs. Peto and Betts,* 9, *Great George's-street, Westminster.*
1856. 7. Du Noyer, G. V., M. R. I. A., 51, *Stephen's-green.*
1832. 8. Dunraven, Earl of, F. R. S., M. R. I. A., *Adare, Co. Limerick.*

Elected.
1836. 9. Enniskillen, Earl of, M. R. I. A., *Florence Court, Enniskillen.*
1844. 10. Esmonde, Sir Thomas, Bart., M. R. I. A., 9, *Great Denmark-street.*
1854. 11. Foote, Frederick J., 51, *Stephen's-green.*
1853. 12. Harkness, Professor, F. G. S., *Queen's College, Cork.*
1856. 13. Haughton, Lieut. John, R. A., *St. Helena.*
1857. 14. Haughton, John Hancock, Esq., *Carlow.*
1850. 15. Head, Henry, M. D., M. R. I. A., *Lower Fitzwilliam-street.*
1858. 16. Hill, J., C. E., *Tullamore.*
1840. 17. Jackson, James E., *Tulliderry, Blackwatertown.*
1839. 18. James, Colonel, R. E., F. R. S., M. R. I. A., *Ordnance Survey Office, Southampton.*
1858. 19. Jones, Rev. H., *Adare, Co. Limerick.*
1832. 20. Kearney, Thomas, *Pallasgreen, Co. Limerick.*
1857. 21. Keane, Marcus, *Beech Park, Ennis, Co. Clare.*
1835. 22. Kelly, John, *Mountpleasant-square.*
1853. 23. Kinahan, George H., *Seaview-terrace, Donnybrook.*
1839. 24. Lansdowne, Marquis of, 54, *Berkeley-square, London.*
1838. 25. Larcom, Major-General, R. E., LL. D., F. R. S., M. R. I. A., *Phœnix Park.*
1858. 26. Leech, Major, R. E., *Mountjoy Barracks, Phœnix Park.*
1840. 27. Lindsay, Henry L., C. E.
1832. 28. Mac Adam, James, F. G. S., 18, *College-street, East, Belfast.*
1840. 29. Montgomery, James E., M. R. I. A.
1856. 30. Molony, C. P., Capt., 25th Regt., Madras N. I., *per Messrs. Grindlay and Co.*, 63, *Cornhill, London.*
1856. 31. Medlicott, Henry, *Roarkee, Bombay.*
1857. 32. M'Ivor, Rev. James, *Rectory, Moyle, Newtownstewart, Co. Tyrone.*
1845. 33. Neville, John, C. E., M. R. I. A., *Dundalk.*
1852. 34. O'Kelly, Joseph, 51, *Stephen's-green.*
1844. 35. Palmerston, Viscount, G. C. B., M. P., 4, *Carlton Gardens, London.*
1832. 36. Portlock, Major-Gen., R. E., F. R. S., M. R. I. A., 58, *Queen's Gardens, Hyde Park.*
1832. 37. Renny, Henry L., R. E., M. R. I. A., *Finglas.*
1854. 38. Smyth, W. W., *Jermyn-street, London.*
1832. 39. Tighe, Right Hon. William, *Woodstock, Innistiogue.*
1834. 40. Verschoyle, Archdeacon, *Rathbarron, Collooney.*
1853. 41. Webster, William B., 104, *Grafton-street.*
1846. 42. Willson, Walter, 51, *Stephen's-green.*
1854. 43. Wyley, Andrew, 51, *Stephen's-green.*
1857. 44. Wynne, Arthur B., 51, *Stephen's-green.*

ANNUAL MEMBERS.

1831. 1. Apjohn, James, M. D., F. R. S., M. R. I. A., *South-hill House, Blackrock.*
1854. 2. Ashton, Samuel, *Woodfield, Newtownbarry.*
1857. 3. Baily, W. H., 51, *Stephen's-green.*
1844. 4. Bective, Earl of, *Headford, Kells.*
1855. 5. Barton, H. M., 5, *Foster-place.*
1858. 6. Bermingham, J., *Milbrook, Tuam.*
1855. 7. Byrne, Griffin, *Lower Mount-street.*
1844. 8. Byrne, Patrick, 27, *Talbot-street.*
1831. 9. Brady, Right Hon. Maziere, M. R. I. A., 26, *Upper Pembroke-street.*
1857. 10. Bandon, Right Hon. Lord, *Castle Bernard, Co. Cork.*
1857. 11. Bolton, George, Jun., 8, *Upper Ormond-quay.*
1840. 12. Callwell, Robert, M. R. I. A., 25, *Herbert-place.*
1857. 13. Carte, Alexander, A.M., M. B., *Royal Dublin Society.*
1858. 14. Cotton, Charles, *Mallow Railway Company, Mallow.*
1834. 15. Croker, Charles P., M. D., M. R. I. A., 7, *Merrion-square, West.*
1855. 16. Clarke, Edward, M. D., *Richmond-hill, South.*
1857. 17. Craig, G. A., C. E., 6, *Ely-place.*
1846. 18. D'Arcy, Matthew, M. R. I. A., *Anchor Brewery, Usher-street.*

Elected.
1849. 19. Downing, Samuel, C. E., LL. D., 6, *Trinity College.*
1832. 20. Dublin, The Archbishop of, *The Palace, Stephen's-green.*
1857. 21. Dowse, Richard, *Blessington-street.*
1852. 22. Doyle, J. B., *Martello-terrace, Sandymount.*
1853. 23. De Vesci, Lord, *Abbeyleix House, Abbeyleix.*
1857. 24. Farran, Charles, M. D., *Feltrim, Malahide.*
1856. 25. Flemming, Lionel J., C. E., 2, *Henrietta-street.*
1857. 26. Frith, R. J., C. E., *Leinster-road, Rathmines.*
1858. 27. Gages, Alphonse, 51, *Stephen's-green.*
1849. 28. Galbraith, Rev. Joseph A., F. T. C. D., M. R. I. A., *Trinity College.*
1856. 29. Ganley, Patrick, *Arboe, Dungannon.*
1849. 30. Gyles, A. M'Gwire, *Saunders' Court, Kyle, Enniscorthy.*
1831. 31. Griffith, Sir R., Bart., LL. D., M. R. I. A., F. G. S., 2, *Fitzwilliam-place.*
1857. 32. Gordon, John, C. E., *Dominick-street.*
1852. 33. Gordon, Samuel, M. D., M. R. I. A., 11, *Hume-street.*
1856. 34. Good, John, *City-quay.*
1831. 35. Hamilton, Charles W., M. R. I. A., 40, *Lower Dominick-street.*
1857. 36. Hampton, Thomas, C. E., 6, *Ely-place.*
1848. 37. Harvey, Professor, M. D., M. R. I. A., F. R. S., 40, *Trinity College.*
1834. 38. Hutton, Thomas, M. R. I. A., F. G. S., 116, *Summer-hill.*
1853. 39. Hemans, George W., C. E., M. R. I. A., 10, *Rutland-square, East.*
1852. 40. Jellett, Rev. Professor, F. T. C. D., M. R. I. A., 6, *Trinity College.*
1842. 41. Jennings, F. M., M. R. I. A., F. G. S., *Brown-street, Cork.*
1858. 42. Jones, William, C. E., 6, *Ely-place.*
1858. 43. Irwin, George W., C. E., 6, *Ely-place.*
1855. 44. Kavanagh, J. W., *Apsley House, Rathmines.*
1857. 45. Kincaid, Joseph, Jun., 3, *Herbert-street.*
1856. 46. Kinahan, J. R., M. D., M. R. I. A., F. L. S., *Seaview-terrace, Donnybrook.*
1853. 47. Kingsmill, Henry, Jun., *Sidmonton, Bray.*
1854. 48. Locke, John, 14, *Henrietta-street.*
1831. 49. Lloyd, Rev. Humphrey, D. D., M. R. I. A., 35, *Trinity College.*
1854. 50. Longfield, Rev. George, F. T. C. D., *Trinity College.*
1855. 51. M'Causland, Dominick, 12, *Fitzgibbon-street.*
1831. 52. M'Donnell, John, M. D., M. R. I. A., 4, *Gardener's-row.*
1852. 53. Mac Donnell, Rev. Richard, D. D., M. R. I. A., Provost of Trinity College, *Provost's House, Trinity College.*
1837. 54. Mollan, John, M. D., M. R. I. A., 8, *Fitzwilliam-square, North*
1851. 55. M'Dowell, George, F. T. C. D., 6, *Trinity College.*
1856. 56. M'Guire, Joseph, C. E., *Kenilworth-square, Rathgar.*
1831. 57. Nicholson, John, M. R. I. A., *Balrath House, Kells.*
1856. 58. O'Brien, Octavius, 23, *Kildare-street.*
1857. 59. O'Meara, Rev. Eugene, A. M., 57, *Great Brunswick-street.*
1832. 60. Patten, John, *Royal Dublin Society.*
1843. 61. Petherick, John, *Knockmahon, Kilmacthomas.*
1857. 62. Phayre, George, C. E., *Strand-road, Sandymount.*
1852. 63. Pigot, Right Hon. Chief Baron, M. R. I. A., 52, *Stephen's-green.*
1857. 64. Porter, William, C. E., 13, *Charlemont-mall.*
1857. 65. Reeves, R., 22, *Upper Mount-street.*
1856. 66. Robinson, Hartstong, 15, *St. James's-terrace, Malahide.*
1852. 67. Smith, Robert, M. D., M. R. I. A., 63, *Eccles-street.*
1852. 68. Sanders, Gilbert, M. R. I. A., 2, *Foster-place.*
1854. 69. Scott, Robert H., A. M., *Salem-place.*
1849. 70. Sidney, F. J., LL. D. M. R. I. A., 19, *Herbert-street.*
1857. 71. Stack, Rev. Thomas, *Trinity College.*
1857. 72. Tait, Alexander, C. E., *Santry.*
1832. 73. Wall, Rev. C. W., D. D., M. R. I. A., 20, *Trinity College.*
1857. 74. Welland, W. J., 48, *Upper Rutland-street.*
1851. 75. Wright, Edward, LL. D., M. R. I. A., *Floraville, Donnybrook.*
1853. 76. Wright, E. Perceval, M. B., M. R. I. A., F. L. S., *Museum, Trinity College.*

ASSOCIATES.

1. Brownrigg, W. B., *Adelaide-road.* 1857–8.
2. Babington, W. D., 25, *Pembroke-road.* 1857–8.
3. Butler, Edmund, 3, *Corrig Castle Terrace, Kingstown.* 1858–9.
4. Geoghegan, H., 4, *Upper Merrion-street.* 1858–9.
5. Green, M. Saunders, 5, *D'Olier-street.* 1857–8.
6. Stephens, T. Classon, 4, *Blackhall-place.* 1858–9.

No. II.

SOCIETIES AND INSTITUTIONS ENTITLED TO RECEIVE THE JOURNAL OF THE GEOLOGICAL SOCIETY OF DUBLIN.

ABERDEEN, .	University Library.
ALBANY, . .	State Library, New York.
AMSTERDAM, .	Royal Academy of Sciences.
BELFAST, . .	Queen's College Library.
BERLIN, . .	Royal Academy of Sciences.
	German Geological Society, per Bessersche Buchhandlung, *Behren-str.*, 7, *Berlin.*
BORDEAUX, .	Imperial Academy of Sciences.
BOSTON, . .	American Academy.
	Natural History Society.
BRISTOL, . .	Institution for the Advancement of Science, Literature, and the Arts.
BRUSSELS, .	Academy of Sciences.
CALCUTTA, .	Asiatic Society.
	Public Library.
CAMBRIDGE, .	Philosophical Society.
	University Library.
CHARLESTON, S. C.	Elliott Society of Natural History, *Charleston, S. C., U. S. A.*, (per J. F. M. Geddings).
COPENHAGEN,	Royal Society of Science.
CORK, . . .	Queen's College Library.
	Royal Institution.
CORNWALL, .	Royal Polytechnic Institution.
DIJON, . .	Academy of Sciences.
DUBLIN, . .	Royal College of Surgeons Library.
	Royal Irish Academy.
	University Library.
	Royal Dublin Society.
	Natural History Society.
	Ordnance Survey Library.
	Geological Survey of Ireland.
	University Philosophical Society.
	University Zoological and Botanical Association.
EDINBURGH, .	Royal Society.
	Wernerian Society.
	Society of Arts.
	University Library.
FLORENCE, .	Society of Physics and Natural History.
FRANKFORT A. M.	The Senkenbergische Naturforschende Gesellschaft.
GALWAY, . .	Queen's College Library.
GENOA, . .	Society of Physics.

GHENT, . .	The Academy.
GLASGOW, .	University.
GOTTINGEN, .	University.
HANOVER, .	Royal Library.
HAARLEM, .	The Institute of Sciences.
KILKENNY, .	Archæological Society.
LAUSANNE. .	Société Vaudoise des Sc. Nat.
LEEDS, . . .	Geological and Polytechnic Society of the West Riding of Yorkshire.
	Philosophical and Literary Society.
LIEGE. . . .	Royal Society of Sciences.
LEIPSIG, . .	Royal Academy of Sciences (Saxony).
	University.
LIVERPOOL, .	The Literary and Philosophical Society.
	Historic Society of Lancashire and Cheshire.
LONDON, . .	Geological Survey, *Jermyn-street.*
	British Museum.
	Society of Arts, *John-street, Adelphi.*
	Royal Institution, *Albemarle-street.*
	Royal Society, *Burlington House.*
	Geological Society, *Somerset House.*
	Linnæan Society, *Burlington House.*
	Geographical Society, 15, *Whitehall-place.*
	Civil Engineers' Institute, 25, *Great George's-street, Westminster.*
	Royal Asiatic Society.
	Royal College of Surgeons.
	Zoological Society.
	Athenæum.
	Literary Gazette.
	The Hon. the East India Company, *East India House.*
LYONS, . .	La Société Imperiale d'Agriculture, d'Histoire Naturelle, et des Arts Utiles.
	Société Linneen de.
	Academie Imperiale de.
MANCHESTER,	Literary and Philosophical Society of. [Sec., R. C. Christie.]
	Geological Society.
	Institute.
MAYNOOTH, .	Library.
MILAN, . .	Imperial Institute of Science.
MISSOURI, .	State Survey and University, *Geological Rooms, Columbia, U. S. A.*
	G. C. Swallow, State Geologist, *Missouri, U. S. A.*
MODENA, . .	Imperial Institute of Science.
MUNICH, . .	Royal Academy of Science.
	Royal University Library.
NEW YORK, .	The Editors of Silliman's Journal of Science and Art.
OXFORD, . .	Bodleian Library.
	Ashmolean Society.
PARIS, . . .	Ecole Polytechnique.
	Geological Society.
	L'Ecole Imp. des Mines.
	Institute of France.
	Bibliotheque Imp.
	Jardin des Plantes Bibliotheque.
PHILADELPHIA,	American Philosophical Society.
	Natural History Society.
PLYMOUTH, .	Plymouth Institution and Devon and Cornwall Natural History Society.
QUEBEC, . .	Literary and Historical Society.
ROTTERDAM, .	Batavian Society.
ROUEN, . .	Academy of Science.
ROME, . . .	The Vatican Library.

SAVANNAH, .	Georgia Hist. Society.
ST. ANDREW'S,	University Library.
ST. PETERSBURG,	Imperial Academy.
	Central Physical Observatory of Russia.
STOCKHOLM, .	Royal Academy of Science.
STRASBOURG, .	Société des Sciences Naturelles de.
TORONTO, C.W.,	Canadian Institute, per Thomas Henning, Esq.
TORONTO, . .	University College.
TOULOUSE, .	Academy of Sciences.
TURIN, . .	Royal Academy.
UPSALA, . .	Royal Society of Sciences.
VIENNA, . .	Imperial Academy of Sciences.
	W. Haidinger, of Vienna, as Editor of the "Jahrbuch der K. K. Geologischen Reichsanstalt.
WASHINGTON,	Smithsonian Institute Library, per Henry Stevens, Esq., *Morley's Hotel, Trafalgar-square, London.*
ZURICH, . .	Universitäts Bibliothek.

No. III.

MEMBERS GAINED.

Life Members.

1. Hill, J., C. E., *Tullamore.*
2. Jones, Rev. H., *Adare, Co. Limerick.*
3. Leech, Major, R. E., *Mountjoy Barracks, Phœnix Park.*
4. Ogilby, William, *Liscleen, Dunmanagh, Co. Tyrone.*

Annual Members.

1. Bermingham, J., *Millbrook, Tuam.*
2. Cotton, Charles, *Mallow Railway Company, Mallow.*
3. Gages, Alphonse, 51, *Stephen's-green.*
4. Jones, William, C. E., 6, *Ely-place.*
5. Irwin, George W., C. E., 6, *Ely-place.*

Associates.

1. Butler, Edmund, 3, *Corrig-terrace, Kingstown.*
2. Geoghegan, H., 4, *Upper Merrion-street.*
3. Stephens, T. Classon, 4, *Blackhall-place.*

MEMBERS LOST FROM DEATH AND OTHER CAUSES.

Deceased.

1. Curran, W. H., 9, *Fitzwilliam-street.*
2. Fitzwilliam, Earl of, *London.*
3. Geoghegan, H., Jun., *Rathmines.*
4. Harrison, Robert, M. D., *Hume-street.*
5. Saunderson, Alexander, *Castle Saunderson, Co. Cavan.*
6. Shirley, E. L., *Carrickmines.*

Resigned.

1. Duncan, James, M. D., *Finglas.*
2. Maguire, Thomas, 46, *Kildare-street.*
3. Salter, J. W., *London.*
4. Wynne, Right Hon. J., *Sligo.*
5. Yeates, George, 2, *Grafton-street.*

Subscriptions in Arrear.

1. Domville, Sir C. W., *Santry.*
2. Flanagan, S. W., *Fitzwilliam-place.*
3. Kirwan, J. S., 15, *Merrion-square.*
4. Macartney, George, M. P., *Balbriggan.*
5. Rowan, Ven. Archdeacon, *Tralee.*
6. Willis, H., *Golden Ball.*
7. Willock, Rev. W., *Enniskillen.*

The Members of the Society now, as compared with the corresponding numbers at the close of last year, will stand as follows:—

	1858.	1859.
Honorary Members,	4	4
Honorary Corresponding Members,	3	3
Life Members,	58	63
Annual Subscribers,	90	76
	155	146

No. IV.

DONATIONS RECEIVED DURING THE YEAR ENDING JANUARY 31, 1859.

Abstracts of the Proceedings of the Geological Society of London, Nos. I to X. Presented by the Society.

Quarterly Journal of the Geological Society of London, Nos. 53 to 56. Presented by the Society.

Proceedings of the Royal Geographical Society of London, Vol. II., Parts 1 to 6. Presented by the Society.

Journal of the Royal Geographical Society of London, Vols. XXV. and XXVII. Presented by the Society.

Journal of the Proceedings of the Linnæan Society, Vol. II., Nos. 7 to 10. Presented by the Society.

The Natural History Review, Vol. I. Presented by the Editors.

Proceedings of the Natural History Society of Dublin, Part II. Presented by the Society.

Proceedings and Papers of the Kilkenny and South-East of Ireland Archæological Society, Nos. 12 to 16. Presented by the Society.

Transactions of the Royal Scottish Society of Arts, Vol. V., Part 1. Presented by the Society.

Proceedings of the Zoological Society of London, Part 25, and Vol. xxvi., pp. 1-368. Presented by the Society.

Proceedings of the Royal Society, Vol. IX., Nos. 31 and 32. Presented by the Rev. Professor Haughton.

Proceedings of the Royal Institution of Great Britain, Part 8. Presented by the Institution.

Proceedings of the Dublin University Zoological and Botanical Association, Vol. I., Part 1. Presented by the Association.

Proceedings of the Society of Antiquaries of Scotland, Vol. II., Part 2. Presented by the Society.

Proceedings of the Literary and Philosophical Society of Liverpool, No. 12. Presented by the Society.

Memoirs of the Literary and Philosophical Society of Manchester, Vols. XIII. and XIV., and Vol. XV. Part 1. Presented by the Society.

Proceedings of the Literary and Philosophical Society of Manchester, No. 1. Presented by the Society.

Continental.

Memoirs de la Societê des Sciences Naturelles de Strasburg. Presented by the Society.
Zeitschrift für Allgemeine Era Kunde Berlin, Nos. 61, 62, and 63.
Jahrbuch der K. K. Geologischen Reichsanstalt Vienna, Vols. I., III., and V., and Parts 1 to 4, Vol. VIII. Presented by the Society.
Annales des Sciences Physiques et Naturelles d'Agriculture et d'Industrie, published by the Societê Imperiale d'Agriculture de Lyons, 2nd Series, Vol. VIII., and 3rd Series Vol. I. Presented by the Society.

American.

The Canadian Journal of Industry, Science, and Art, Nos. 13 to 17. Presented by T. Henning, Esq., Canadian Institute.
The American Journal of Sciences and Arts, Nos. 73 to 78. Presented by the Editors.

Miscellaneous.

On the Tides and Tidal Currents of the Irish Sea and English Channel. By the Rev. S. Haughton, A. M., F. T. C. D. Presented by the Author.
On the Old Red Sandstone Conglomerate of the County of Waterford. By the Rev. S. Haughton, F. R. S. Presented by the Author.
Address delivered at the Anniversary Meeting of the Geographical Society by Sir R. Murchison, G. C. B., President. Presented by the Author.
Annual Report and Transactions of the Plymouth Institution, and Devon and Cornwall Natural History Society, 1857–58. Presented by the Society.
Contributions to the Meteorology and Hydrography of the Indian Ocean, Part 1. By Charles Meldrum, A. M. Presented by the Author.
On some Additions to the Knowledge of the Cretaceous Rocks of India. By Thomas Oldham, LL.D., Superintendent of the Geological Survey, India. Presented by the Author.
On a Fossil Cirripede. By James MacAdam, Esq. Presented by the Author.
Report of the British Association for the Advancement of Science. Dublin, 1857. Presented by the Association.
Report on Canadian Graptolites. By James Hull, Esq., Albany. Presented by the Author.
On the Microscopical Structure of Crystals, &c. By H. C. Sorby, F. R. S. Presented by the Author.
American Geology. A Letter on some Points of the Geology of Texas, New Mexico, Kansas, and Nebraska. By Jules Marcow. Presented by the Author.
Icones de Geologie Paleontologique. By Jules Marcow, Esq. Presented by the Author.
Notes pour servir a une Description Géologique des Montagnes Rocheuses. By Jules Marcow, Esq. Presented by the Author.
Esquisse d'une Classification des Chaines des Montagnes d'une partie de l'Amerique du Nord. By M. Jules Marcow. Presented by the Author.
Earthquake Catalogue and Discussion, &c. &c. By R. and W. Mallet. Presented by the Author.
Sermons in Stones (Fifth Edition). By D. M'Causland, Esq. Presented by the Author.
The Athenæum for the year 1858. Presented by the Editors.
The Literary Gazette for the year 1858. Presented by the Editors.
The Journal of the Society of Arts for the year 1858. Presented by the Editors.
On the Genus Oldhamia. By Professor Kinahan, M. D. Presented by the Author.

Maps.

Quarto sheets of the Geological Map of Ireland, 22 in number, viz., No. 51, N. W.; N. E.; S. W.; S. E. No. 52, N. W.; N. E.; S. W. No. 35, N. E. No. 45, S. W. No. 46, N. W. No. 56, N. E., and 3 Books of Data. No. 40, S. E. No. 50, S. E. No. 55, N. W. No. 55, N. E. No. 56, N. W. No. 56, S. W. No. 55, S. E. No. 56, S. E. No. 58, N. E. No. 58, N. W. No. 59, N. W.

No. V.—ABSTRACT OF TREASURER'S ACCOUNT FOR THE YEAR ENDED DECEMBER 31, 1858.

Dr.

1858.		£ s. d.
To Balance from last year's Account,		71 14 8
— Amount of Subscriptions received for year ending this date:—		
— Life Composition,	£30 0 0	
— Admission Fees,	9 0 0	
— Annual Subscriptions,	60 15 0	
		99 15 0
— Amount of Dividend received on Government Stock,	3 9 4	
— Sale of Admission Tickets,	0 9 6	
		3 18 10
		£175 8 6

Cr.

1858.		£ s. d.
By Editors of "Natural History Review," to June 30, 1858 (per Draft 10,287),		15 0 0
— Messrs. Forster's Account for Illustrations to Vol. VII., for 1857 (per Draft 10,288),		10 11 6
— Assistant Secretary, Gratuity to Attendant (per Draft 10,289),	1 10 0	
— Two years' Subscription to Palæontographical Society,	2 2 0	
Sundries,	8 6 5	
		11 18 5
— Treasurer to invest in Government Stock (per Draft 10,290),		30 0 0
— Sundries, per Assistant Secretary,	6 1 10	
— Mr. Tallon's Account for Stationery,	1 17 4	
— Mr. Keogh's Account for Binding,	2 5 4	
		10 4 6
— Editors of "Natural History Review," to Dec. 31, (per Draft 10,292),		15 0 0
— Assistant Secretary's Salary to June 30, (per Draft 10,293),		10 0 0
— Sundries, per Assistant Secretary, (per Draft 10,294),	11 4 1	
— Mr. Allen, for mounting Geological Map of Ireland,	6 6 0	
		17 10 1
— Edmondson and Co., for Moderateur Lamps, (per Draft 10,295),		8 5 6
— Mr. Gill, for Printing for one year, (per Draft 10,296),		6 13 9
— For Illustrations to Vol. VIII., Part 1, of Society's Journal (per Draft 10,297),		14 0 0
— Assistant Secretary, Salary to December 31, (per Draft 10,298),		10 0 0
		159 3 9
— Balance in Bank,	£11 4 9	
— Cash in hands,	5 0 0	
		16 4 9
		£175 8 6

GILBERT SANDERS, *Treasurer*.

The ballot having closed, the following gentlemen were declared duly elected:—

President.—Rev. Professor Haughton, F.T.C.D., F.R.S.

Vice-Presidents.—Rev. H. Lloyd, D.D., S.F.T.C.D., F.R.S.; Sir Richard Griffith, Bart., LL.D.; Lord Talbot de Malahide; Robert Callwell, M.R.I.A.; Rev. J. A. Galbraith, F.T.C.D.

Treasurers.—Gilbert Sanders, M.R.I.A.; F. J. Sidney, LL.D.

Secretaries.—Joseph Beete Jukes, M.A., F.R.S.; E. Perceval Wright, M.B., F.L.S.

Council.—John Kelly, Esq.; George M'Dowell, F.T.C.D.; Samuel Downing, LL.D., C.E.; John B. Doyle, Esq.; Dominick M'Causland, Esq.; J. R. Kinahan, M.D., F.L.S.; G. V. Du Noyer, M.R.I.A.; Alexander Carte, A.M., M.B.; Robert Mallet, C.E., F.R.S.; Edward Wright, LL.D.; James Apjohn, M.D., F.R.S.; Professor Harvey, M.D., F.R.S.; Robert H. Scott, A.M.; Samuel Gordon, M.D.; Wm. H. Baily, F.G.S.

The Society then adjourned till 8 o'clock.

ADJOURNED ANNIVERSARY MEETING, FEBRUARY 9, 1859.

Rev. Professor Haughton, F.T.C.D., F.R.S., President, in the Chair.

The Minutes of last General Meeting having been read, were approved of, and signed by the Chairman.

The President then proceeded to deliver the following

ADDRESS.

Gentlemen,—The return of our Anniversary Meeting brings with it the duty to your President of preparing an Annual Address. In this Address many expect to find a registry of the geological work done during the year; but as this task is usually undertaken by the President of the Geological Society of London, whose Anniversary Meeting falls at the same time of the year as our own, and also as I believe that I might occupy your time better than by a dry detail of the heads of geological papers read before one Society or another, I shall take the liberty to confine my record of geological progress to the papers read before ourselves, and to select from those read and published elsewhere such as seem to me particularly worthy of our notice.

Before proceeding to do so, however, I am reminded of another and more sacred duty that devolves upon me: to bring, for a few passing moments, before your memory the excellences and virtues of one of our most distinguished Members, who has passed from among us since we last assembled here.

Dr. Robert Harrison was a Member of this Society from the year 1832, from which period to the time of his death in 1858, he took a

lively interest in our proceedings. He was a Member of the Council, and took an active part in the management of the Society during its earlier years. The interest he felt in geological pursuits arose from their connexion with the comparative anatomy of the Vertebrata—a subject with which he was profoundly conversant, and which he justly regarded as being a necessary accompaniment of a study of human anatomy. He was accustomed in his lectures to advert, whenever it was possible, to the geological discoveries made by Cuvier and Owen in this department, and to direct the attention of his anatomical classes to the exact and scientific bases on which the reasoning of those anatomists was founded. It was, however, as a teacher of Human Anatomy that Dr. Harrison acquired his high and well-deserved reputation; and a few passing words on the influence he exerted on the study of Practical Anatomy in this city will certainly not be considered misplaced in the halls of the University which he adorned by his talents, and whose students were instructed both by his lectures and example.

I have heard many persons who had laboured through the preparatory stages of the medical profession in Dublin, before Harrison's time, declare that no one who had not experienced it could imagine the difficulties to be encountered by the student of Practical Anatomy who was compelled to acquire his knowledge without the assistance to be derived from such a book as Harrison's "Dublin Dissector." This book was published in 1827, and was one of the first and one of the most successful ever published on Practical Anatomy. It at first appeared anonymously, and therefore the popularity and repute which it speedily acquired may justly be regarded as a testimony to its intrinsic worth. It has passed through five large editions, the fifth being published in 1847, and is, as I am informed by most competent authorities, still esteemed as the best of all the manuals of Anatomy, and as the most perfect "Dissector" in arrangement, matter, and style.

Dr. Harrison commenced his career as a teacher of Anatomy in 1820, in which year he received, as his first pupil, Dr. Shewbridge Connor, of Carlow. In 1821 his name appears among the Demonstrators of the Royal College of Surgeons. In the year 1827, on the 4th of August, he was elected Professor of Anatomy and Physiology in the same College. He held this important office until 1837, when he was elected Professor of Anatomy and Physiology in the University of Dublin—a position which he occupied until the period of his lamented death in 1858. It thus appears that he spent thirty years of his life in the public teaching of Human and Comparative Anatomy—ten years in the College of Surgeons, and twenty in Trinity College. He was twice elected President of the College of Surgeons, and retained throughout his life the regard and esteem of the leading members of that public body. In 1831, and for some years subsequent, Dr. Harrison took an active and public part in the management of the affairs of the College of Surgeons. He was repeatedly selected to represent the College in applications to Government in this country and in London. On all such occasions his acumen,

intelligence, and great natural powers of declamation secured the warmest praise from his colleagues, and made him a formidable opponent to those from whose views he differed.

Besides his "Dublin Dissector," Professor Harrison published, on the "Anatomy of the Arteries," a work considered by many teachers of Anatomy the best yet published on the subject. Other works abound in more minute detail; but, in the opinion of good judges, Harrison in this book has vigorously caught the leading facts of the subject, and placed them before his readers in that clear and perspicuous style which constituted the principal charm of his lectures. He contributed several articles of great merit to Todd's "Cyclopædia of Anatomy and Physiology;" for example, those on the "Arm" and "Bladder" were written by him. He also made several interesting communications to the Royal Irish Academy on Comparative Anatomy and other subjects.

As a public lecturer Dr. Harrison was not surpassed by any teacher in this country or in England. His care in preparing his lectures was well known, and his judgment in the selection of his topics was remarkable. He never attempted to dazzle the hearers whom it was his duty to teach, and he always preferred leading them with him through the highways and beaten tracks of his subject, rather than invite them to follow the doubtful by-paths of half-proved hypotheses and theories. This excellence of Harrison was turned into an accusation against him, that he did not keep pace with the progress of his subject, particularly in Physiology. Nothing can be more mistaken than this accusation. Professor Harrison diligently acquainted himself with all the real advances made in Physiology, and introduced them into his lectures; but he certainly, and properly, abstained from resting his teaching on crude microscopic observations, and never taught as an established fact what was at best, probably, only a successful guess.

He enjoyed the friendship and respect of many of the leading members of the Medical Profession in London, including Sir Astley Cooper and others. In the year 1832 he was elected Surgeon to the Jervis-street Infirmary, and in 1855 Surgeon to Steevens' Hospital.

Of the esteem in which he was held by his pupils I cannot say more than is contained in the following, which I have received from one of his most intimate pupils:—

"During the time I was an apprentice of Harrison's he had a number of pupils, and I can faithfully say he was held in great esteem by every one of them. None of them disliked him—many loved him. For my part I can say that, as his former pupil, his assistant, and his friend, I felt bound to him by no common tie of friendship. I knew him to be the best, the most considerate, and kindest of fathers, the warmest of friends. . . . . I speak of him as I always found him—kind-hearted, liberal, and generous; and up to the present moment I cannot think of his sudden removal without the deepest emotion."

I shall not speak further of Harrison's merits as a lecturer, of which, I presume, almost every person who hears me is in a position to judge

for himself. His conscientious care in preparing for his public lectures was shown on the very night of his death, on which occasion he was occupied in preparing for the following day's lecture until within a few moments of the time he was summoned himself to answer the roll-call of his Maker. It was to be the last lecture of his course, and he had delivered it, possibly, a score of times; yet he was not satisfied to appear before his class with what had cost him nothing, and he was occupied on the last evening of his life, as he had been for a considerable part of his career, in preparing new illustrations and new forms of expression which might serve to impress more effectually an old and familiar subject upon the attention and recollection of his hearers.

An able and successful teacher has passed from among us, but his example still lives, and will bear fruit among his followers. Let us imitate his perseverance and his patient industry, though we cannot command his ability; but, above all, let us do justice to the memory of a great and good man, and not allow any shade of jealousy, or recollection of ruffled feelings, to prevent us from uniting to honour the memory of one who did more than any, living or dead, for the last fifty years, to raise the standard of Medical education in Ireland, and to make the Dublin School of Anatomy respected in other countries.

During the past year an unusually large number of papers has been read before the Society, embracing such a variety of subjects as to give good promise for the future. We have had fourteen papers on Descriptive Geology and Palæontology, and six papers on Physical Geology and Mineralogy.

I. DESCRIPTIVE GEOLOGY AND PALÆONTOLOGY.

Dr. Alexander Carte contributed to our Journal a paper on a "Specimen of Fossil Elephant," presented by Dr. Tuffnell to the Museum of Trinity College. His paper is characterized by his usual conscientious accuracy, and contains some valuable hints as to the geographical distribution of the fossil elephants.

Dr. Kinahan has brought under our notice, in two papers, the highly interesting question of the Fossils of Bray Head, and has also published a detailed account of the genus Oldhamia, from the same locality, in the "Transactions of the Royal Irish Academy." In our own Journal Dr. Kinahan's paper is illustrated with two lithographic Plates, one of which contains figures of the new fossil discovered by him at Bray (the *Histioderma Hibernicum*); and in a subsequent paper (not yet printed) Dr. Kinahan has made known the existence of another new fossil from the Cambrian beds of Bray Head. Like all the other fossils hitherto found in rocks of this age, its organic character and relations are obscure as compared with those of the fossils of newer epochs, and the eye, untrained in the search for organic remains, might easily pass over it without recognising its existence; but I think that it will prove to be a genuine addition to the Fauna of the Cambrian

epoch, and that the objections that have been raised against it will prove to be as little founded as the jokes that have been expended upon the antiquarians with respect to the true character of the Ogham inscriptions. Dr. Kinahan has done this Society, and myself as its President, the honour of calling the new fossil after my name. Although I am thus, to a certain extent, an interested party in establishing the existence of the *Haughtonia pœcila*, yet I am certain that those who differ from me on this question will gladly join with me in bearing testimony to the zeal and ingenuity with which Dr. Kinahan has worked out the unpromising grits and slates of Bray Head. His unremitting labours have led to the conclusion that the same forces and agents that are now at work on our sea-shores and mud-banks were in operation from the earliest period at which organic life appeared on our globe. This result is obtained by Dr. Kinahan from a comparison of the tracks or physiological impressions left by the Cambrian Zoophytes and Annelids with those now produced between tide-marks by their living congeners.

To those who, like myself, believe that we can find, if not the first, at least, nearly the first, inhabitants of our planet, embedded in its crust, the conclusions arrived at by Dr. Kinahan are of the highest interest, as they form a link in the chain of arguments that lead to the conclusion that geological time is but as a moment, in comparison with the preceding existence of our planet; and that during the whole period of life on the globe, the physical agents employed have been similar to those now in operation.

Sir Richard Griffith has given us a paper on the Posidoniæ occurring at Rush and Kinsale, two totally different geological deposits; but both agreeing in certain physical characters, the presence of which has given the rock its appearance of black fine mud slate, which it exhibits in both localities. The difference in form observable in some of the specimens from Kinsale, I think, may be fully accounted for by the pressure that accompanied the cleavage of the rock. The interesting fact demonstrated by the specimens exhibited to us by Sir Richard Griffith, of the occasional occurrence of the two valves in natural apposition, removes all doubt that might otherwise have existed as to the true character of Posidonia, and shows that it was a Bivalve, probably closely allied to Avicula. This fact of the occurrence of the two valves of Posidonia in conjunction, has been confirmed by several other observers; by Dr. Carte and Mr. Hargrave at Rush, and by Mr. Foot, of the Geological Survey, at Ennis, in Clare.

In concluding his paper, Sir R. Griffith remarks that "it is interesting to find the Posidoniæ occurring in the fine-grained, dark-coloured shales throughout the entire range of the carboniferous series in Ireland, from the base of the marine coal formation to the upper portion of the yellow sandstone group of strata; and it is remarkable that in both cases they are accompanied by the fossil, *Goniatites striolatus*. It only remains to remark, in conclusion, that notwithstanding the prevalence of these fossils in certain groups of strata, they would rather seem to afford an indication of mineral conditions and of mechanical depositions than be of

rigid application in the determination of geological subdivisions, as it appears that their presence is dependent upon the predominance of argillaceous rather than of calcareous or siliceous matter in the bottoms in which they are found; but, however this may be, we can safely affirm that they are eminently characteristic of the carboniferous series; and it is satisfactory to be able to prove that these remains were true lamellibranchiate bivalves, as given in the Table of Fossils appended to my Geological Map of Ireland."

The value of this paper is considerably enhanced by the beautiful lithographs with which it is illustrated.

Mr. Hargrave's paper on the "Geology of Balbriggan and Rush" fully confirms Sir Richard Griffith's and Mr. Jukes's views as to the geological position of the Calp beds in which the Posidoniæ occur.

Mr. Birmingham has read before us the second part of his paper on the "Drifts of West Galway and East Mayo." In this portion he has somewhat modified the views expressed in his former paper, and appears disposed to admit of the introduction of ice as a partial agent for the transport of materials, in addition to the influence of water, which he illustrated so well in his former paper. This modified view appears to me more likely to meet with acceptance among geologists, than the reference of all the phenomena of the drift to aqueous causes alone. I would congratulate the Society on the acquisition of so intelligent and laborious an observer as Mr. Birmingham has proved himself to be; and it is to be hoped that the valuable papers he has already laid before us are only the commencement of a series to be yet read to this Society.

The friends of geological progress in Ireland must congratulate the Society on the acquirement of valuable aid, in the appointment of Mr. W. H. Baily as Palæontologist to the Irish branch of the Geological Survey. This gentleman has already contributed some valuable papers to our Journal, one of which is particularly important, as establishing the analogy between the lower coal-measures of Leinster and those of Coalbrookdale. Mr. Baily's paper, in which this interesting analogy is pointed out, describes a remarkable species of what was formerly called *Limulus*, from the coal-shales of Bilboa Colliery, county of Carlow. The specimens of this Crustacean, described by Mr. Baily, were found by Mr. G. H. Kinahan, of the Geological Survey. Mr. Baily proposes to remove from the genus Limulus, and place under the genus *Bellinurus* (König), both the Bilboa species, and several others from Coalbrookdale and the North of Ireland, described by Mr. Prestwich and Colonel Portlock. His reasons for separating those fossils from Limulus, and forming of them a new genus, are the following:—

"I would here offer a few remarks on the genus Limulus, in which all these coal-measure Crustacea have been hitherto included, and which I now propose, from their greater affinity with the Trilobites, to remove, and constitute a new genus under the name of Steropis [*Bellinurus*] for the following reasons. In the first place, their general form and size bear a much stronger resemblance to several of the Trilobites than they do to the recent Limulus, from which they differ in possessing (although not

so perfect as in the Trilobites) a more distinct trilobation, with the abdomen separated into segments. The abdominal or caudal shield corresponds almost completely in point of size and form with that of Ampyx, Trinucleus, &c.; and the characteristic spiny termination of the pleuræ to that of Acidaspis and Paradoxides. The possession of legs and articulation of the caudal spine, which they are said to be provided with, would connect them with the Jurassic and recent Limulus; although there is a striking analogy to the latter case presented by some of the Silurian Trilobites, as *Phacops longicaudata*, in which species there is a preat prolongation of the caudal extremity into a spine, which is, however, destitute of articulation. The presence of a facial suture, which I have detected in the species hereafter described, would offer still greater affinity to the Trilobites, as being peculiarly characteristic of that group. The great difference, in point of time, between the deposit of the lower coal-measures, in which Crustacea of this character first appear, and the upper Jurassic, where they approach very closely to the recent forms, would again account for their closer alliance to the Trilobites, thus leading on in beautiful gradation to that great and important group of the Crustacea which is characteristic of, and obtains its maximum development in, the older palæozoic rocks."

Mr. Baily has also contributed to our Journal lists of fossils of considerable value from Cahirconree, Derrymore Glen, Ballycar, Reaghfadda, from the Silurian slates of the east side of the Slieve Phelim group, found by Mr. A. B. Wynne, of the Geological Survey, including several new species of much interest.

Mr. Jukes and Mr. Du Noyer have given a paper to the Society which raises some questions of considerable interest as to the physical conditions of the south of Ireland during the earlier parts of the Old Red Sandstone period. It appears from Mr. Jukes's investigation of the geology of Cahirconree that horizontal beds of the Old Red Sandstone formation rest in that mountain partly on Silurian beds, and partly on beds of a conglomerate called by him the "Inch Conglomerate," and thus described:—

"The Silurian rocks, which are a good deal contorted, end in a steep precipice of about 500 feet, nearly vertical, against which the horizontal beds of Old Red Sandstone have been deposited. That this feature is not the result of any dislocation subsequent to the formation of the Old Red Sandstone is shown by the fact that the beds of that formation stretch across the top of this Silurian precipice in unbroken sheets of a conglomerate containing quartz pebbles, that can be traced, in all directions, for a considerable distance, those conglomerates resting on the one side on the Silurian rocks, and reposing on the other on other beds of conglomerate that can be traced round one side of the glen, and for several miles in the S. W. direction. These latter lower beds of conglomerate are of a very remarkable character, containing angular blocks, fragments of mica schist, gneiss, felstone, slate, &c. No gneiss or mica schist is now known in the neighbourhood, or anywhere nearer than Galway;

yet some of these blocks are a foot in diameter, and but very slightly rounded at the corners. The conglomerate which we call the Inch Conglomerate, from the name of a place on the south coast where it is well seen, dies away towards the west, and, from a thickness of 400 feet in Derrymore Glen, thins out to six feet near Minard, where it terminates to the west."

In addition to the fragments composing this conglomerate mentioned by Mr. Jukes, I observed fragments of granite, with white mica, resembling the granite fragments of the Old Red Sandstone of Waterford, and in both cases probably derived from the great Leinster axis of granite. If this conjecture should, on further examination, prove correct, it may serve to fix the geological age of the Inch Conglomerate, and remove some of the obscurity that at present envelopes the junction of the lower carboniferous beds of the south of Ireland with the deposits of unquestionably Silurian age found at Dingle. It might also serve as a positive basis for speculation, as to the conditions of sea and shore, of the Old Red period in Ireland, which admitted of the transport of large boulders and coarse pebbles from the Leinster mountains simultaneously to the south of Waterford and west of Kerry, there to be rolled and pounded by the rough billows of an older Atlantic into the red conglomerates that now form the columnar cliffs of Waterford, or rest upon the flanks of Cahirconree.

The Rev. Eugene O'Meara continues his researches into the forms of the fossil Diatomaceæ, and has laid before us during the past Session the results of his examination of some specimens from the Lower Eocene Tertiaries of Hampshire. The Diatoms found by Mr. O'Meara in these beds are all of recent forms, two belonging to brackish water, and but one fragment of a salt-water species (*Coscinodiscus radiatus*).

II. PHYSICAL GEOLOGY AND MINERALOGY.

Captain Molony, of the Madras Army, has brought under our notice an interesting speculation as to the origin of Magnesian Limestone, by which he proposes to account for its atomic chemical composition, and also for the absence of fossils often characteristic of this formation. His theory, which is ingenious, is based on the law of interchange of oceanic currents by virtue of difference in relative specific gravity. If from any cause carbonate of lime happens to collect in solution in the waters of one ocean, while carbonate of magnesia accumulates in another ocean, and a communication be opened up between these oceans—as between the Mediterranean and Atlantic, or between the Red Sea and Indian Ocean—the result will be an interchange of sediments, accompanied by an accumulation of deposit in the sea, into which the water of heavier specific gravity flows. To use his own words:—

"Suppose one sea to have held carbonate of lime in solution, and a neighbouring sea, carbonate of magnesia; then, according to Maury's theory, a surface and under-current from one sea to the other must have been established, by reason of the difference of specific gravity of the two

seas,—the specific gravity of magnesia being greater than that of lime; and these currents must have lasted so long as that difference existed, which may have been for thousands of years. Thus carbonate of magnesia may have flowed into the one ocean, and carbonate of lime into the other, till equilibrium was set up between them, which would have occurred on the proportions having become one to one, or, in other words, when they had mingled together, and gained the ratio to form magnesian limestone; and then an age of tranquillity and subsidence may have commenced, during which the mixed carbonates may have been deposited at the bottom of the sea, and our dolomites and magnesian limestones have been formed."

The aqueous theory of dolomites is gaining ground among geologists, and this speculation of Captain Molony's appears worthy of attention. It would, however, be more complete if he had shown the probability of separate deposits or solutions of the lime and magnesian carbonates occurring in two different seas. So far as we at present know, the relative quantities of lime and magnesia (existing generally as sulphate of lime and chloride of magnesium) appear to be the same in all our oceans,—indicating that the relative supplies of these earths brought down by rivers is nearly constant, and the solvent action of the sea-water upon them pretty uniform. No doubt, some special cause might exist at a particular epoch which would develop an unusual amount of magnesia in one sea or locality, while there was no such development in a neighbouring sea. Such a cause is found in volcanic action,—a view of the case which would bring the aqueous and igneous theories of dolomitization in relation with each other. We should welcome among us a fellow-labourer like Captain Molony, who has given good promise of future eminence as a geologist, and who occupies a position at Madras in which he may contribute much information for our benefit.

An Analysis of Anorthite, constituting an essential element of a crystalline Diorite, from the Ural Mountains, has been read before us by Mr. Robert H. Scott. It is identical in composition with the Anorthite which I have shown to form an essential element of the Syenite of Carlingford Mountain.

A question of much interest is raised by the proof of the occurrence in large quantity, in rock masses, of a mineral hitherto considered a rarity of our mineralogical cabinets. A similar case was established by myself in a paper on Lepidomelane, read before the Geological Society of London, in which I showed that the common black mica of Leinster and Donegal is probably identical with the rare Lepidomelane of Soltman.

In the case of the Carlingford Syenite, I have shown that it is probable that this peculiar form of felspar (Anorthite) is only the result of the action of the carboniferous limestone of the locality acting as a flux to the molten granite, and converting its alkaline felspar into a lime felspar. Of course, it is not to be supposed that such an agency was at work in every case in which we find a lime felspar entering into the composition of an igneous rock; but it is worth while to remember that such

cases may occur, and that we are not always to attribute peculiarities of composition of igneous rocks to original differences, when they may often be as easily explained by their adulteration and admixture with rocks which have modified and altered them, so as to change even the elementary minerals of which they are composed.

Among the most valuable of the papers contributed to our Society during the past year may be reckoned those read before us by M. Alphonse Gages, partly on account of the interest of the facts described by him, but principally in consequence of the important views they open up with reference to the genesis of rock masses, particularly those of metamorphic origin. M. Gages' first paper, on "Pseudomorphic Tremolite," was read before this Society in January, 1858, and the facts contained in it, with many others superadded to them, were subsequently made the basis of a general theory of metamorphism in a paper read to us in November, 1858. The substance of this latter paper was also communicated to the Meeting of the British Association held at Leeds, by the liberal aid of which body we may hope to find M. Gages' ideas developed into a consistent and complete theory of metamorphic action, based upon the only sure foundation of such speculations—viz., chemical and chemico-mechanical analyses of metamorphosed rocks.

I shall only quote from M. Gages' paper a brief statement of his method of procedure, and its application to the Pseudomorphic Tremolite, on which he first commenced his researches:—

"The simple action of acids or other dissolvents on a given rock, removing from it certain parts, and leaving others exposed to view, will sometimes enable us to observe its mode of formation, as well as that of its decomposition. It is important to remark that the mechanical state of the substance to be acted on is not an indifferent element in these experiments; the chemical result will, of course, be the same, whether the substance to be acted upon be in the form of powder, of laminæ, more or less fine, of rock fragments, or of crystals cut in the direction of the cleavage; but the true interpretation in reference to the value of the several phenomena observed will be essentially different as regards the geological origin of the object of inquiry.

"In support of this proposition I may allude to some examples lately supplied by the experiments which I have made. In taking, for instance, a fibrous dolomite, such as that found near Miask in the Ural Mountains, the ordinary analysis of the mineral will give us a quantity of lime, magnesia, and silica, represented by the following numbers:—

Carbonate of lime, ...	57·483
,, magnesia, ...	40·974
Sesquioxide of iron, and alumina, . . .	0·411
Water, and organic matter, ...	0·239
Silica, ...	1·095
	100·202

"From this analysis it would appear that the mineral to which I have referred is a dolomite rock; but it affords us no information what-

ever relative to its real nature or origin. If, however, instead of operating on the mineral in the form of powder or fragments coarsely broken up, we proceed by means of diluted hydrochloric acid acting on a single fragment of moderate dimensions cut in the direction of the fibres, we shall observe, after continuing the process for some days, that there will be left an asbestiform skeleton, of which the following is the composition:—

Silica, ...	68
Magnesia, ...	29

—numbers representing a magnesian Tremolite; and it is from this simple difference in the manner of conducting the experiment that we have arrived at a result so different from the former, thus enabling us to trace, so to speak, the real origin of the rock in question."

I had, myself, occasion to apply M. Gages' chemico-mechanical analysis to some Indian minerals from Nágpur, and was fortunate enough to discover a remarkable example in one of them, hitherto undescribed, and which I have named Hislopite, after the zealous missionary who brought it to England. I found this mineral with the form and crystallization of Calcite, of a bright-green colour, which colour turned out to be owing to the presence of one of M. Gages' superposed skeletons, composed of Glauconite, and suggesting a most interesting series of reflections as to the relative date, mode of superposition, and genesis of the compound mineral. M. Gages himself is engaged in applying his theory to the solution of one of the most difficult and interesting questions in chemical geology—I mean the origin of Serpentine, both Verd Antique and compact, or porphyritic. In this investigation I most heartily wish him success, and if zeal and intelligence can command it, I feel that he well deserves it. M. Gages has also laid before us the analysis of a Phosphate of Alumina (hydrated), allied to Peganite and Fischerite, found by Mr. G. H. Kinahan, of the Geological Survey, near Loughill, county of Limerick.

On the whole, the Society may congratulate itself on a year of considerable activity, during which several fresh labourers of much promise have joined us, and helped, with the assistance of our old and tried hands, to produce a Part of our Journal, of which we have no need to feel ashamed. Many causes have combined to produce this increased activity among our Members, but among the chief may be reckoned the speedy and accurate printing of our Journal in the pages of the "Natural History Review." In this Journal are now printed the "Proceedings" of almost every Scientific Society in Ireland, and it is well known both in England and abroad as the organ that represents the state and progress of Irish Science. Although all Science is one, and knows no country, yet it is highly desirable that each country should obtain her fair share of credit for the contributions she may make, however humble, to the common stock; and I feel sure that all who hear me will agree with me in thinking that it is more worthy of their true position, that the cultivators of Science in Ireland should publish their investiga-

tions through the medium of a recognised Irish Scientific Journal, rather than in the pages of an English or Scotch periodical.

Having completed my survey of the geological work done by ourselves during the past year, I shall now ask your attention to one or two important publications bearing upon Geology which have appeared elsewhere during the same period. In doing so I shall not attempt to notice all that is of value, but shall confine my attention to a few publications which are of peculiar importance, either in consequence of the novelty of the views they contain, the valuable results they embody, or the authority of those who have given them countenance and support.

EARTHQUAKE CATALOGUE.

Among the published works of the past year, of value to the scientific geologist, must be reckoned the "Earthquake Catalogue" of the British Association, the joint product of the industry and intelligence of the Messrs. Mallet.

This important Catalogue is now completed to the year 1850, and will form a valuable work of reference, and a starting-point for future investigators. The *fourth* Report, which accompanies the Catalogue, contains a vast amount of information, particularly with respect to seismometers and modes of measuring direction and depth of earthquake shocks, which cannot fail to prove of the highest value, and lead to important results, as soon as the number of accurate observations shall allow of inferences being drawn, on which reliance can be placed.

MR. SORBY'S THEORY OF METAMORPHIC ROCKS.

A most important paper has been published by Mr. Sorby in the Proceedings of the "Geological Society of London," on the application of the microscope to the study of the physical origin of the igneous rocks, including lavas, traps, granites, and quartz veins.

Mr. Sorby is already well known by his researches on the mechanical origin of cleavage, and on the physical conditions of deposition of sandstone rocks, with reference to currents of the seas that produced them. He has placed geologists under a further obligation to him by the remarkable application he has made of the microscope as an instrument of physico-geological research.

His idea may be stated in a few words, and is as follows :—1. If a crystalline body be formed by sublimation, there may be left in its substance *air or vapour* cavities, discoverable by microscopical examination. 2. If the crystalline mass be deposited from aqueous solution, or in presence of water that cannot escape, we shall have *fluid cavities* hermetically sealed up, the contraction of the contents of which gives us a measure of the conditions of temperature and pressure under which they were formed. 3. If the fluid filling the cavity be solid at ordinary temperatures, then we shall have microscopical cavities filled with glass or stone, according to the conditions of cooling; these form *vitreous or lithoid cavities*, and these glass and stone cavities may, and often do, contain spherical void spaces that measure the amount of contraction

undergone by the contents of the cavity in cooling, and thereby enable us to ascertain, within certain limits, the conditions of temperature and pressure under which the rock became crystalline.

The real difficulty in the interpretation of the microscopical phenomena is one pointed out fully by Mr. Sorby himself, viz., that the amount of contraction depends upon *both* the original temperature and pressure, and that therefore our conclusions will be very different, according as we assume, as we must necessarily do, various hypotheses as to either one condition or the other.

Mr. Sorby has tabulated as follows the results of his observations on the two extreme hypotheses:—

1. That there was no pressure save that of the contained vapour.
2. That the temperature was constant, and 360° C., the pressure varying.

His statement is:—

"In order that the various results may be compared more conveniently, I subjoin the following table. The first column gives the temperature in degrees Centigrade requisite to expand the fluid so as to fill the cavities, if the pressure was not greater than the elastic force of the vapour, which, of course, is the lowest temperature at which the rock can have been consolidated, since the excess of pressure could not be less than nothing. In the other column is given the pressure in feet of rock requisite to compress the fluid so much that it would just fill the cavities at 360°, being, therefore, the actual pressure if in each case the rock was consolidated at that temperature.

	Temperature.	Pressure.
Trachyte of Ponza,	356°	4,000
Elvan at Gwennap,	320	18,100
Granite at St. Austle,	256	32,400
Mean of the Cornish elvans,	250	40,300
More recent veins of granite at Aberdeen,	245	42,000
Mean of Cornish granites,	216	50,000
Elvan at Swanpool, near Falmouth,	203	53,900
Granite from the Ding Dong Mine, near Penzance,	162	63,600
Mean of the Highland porphyry-dykes,	135	69,000
Exterior of the main mass of the granite at Aberdeen,	135	69,000
Mean of the Highland granites,	99	76,000
Centre of the main mass of the granite at Aberdeen,	89	78,000

"It will thus easily be seen that, if pressure is not taken into account, there is a gradual decrease in temperature on passing from trachyte to granite; whilst if, as is far more probable, the temperature was nearly the same, the pressure increases in passing from trachyte through elvans to granite; and I think all geologists will agree with me in thinking that this is a very satisfactory result."

Objections have been raised to Mr. Sorby's method of inquiry, based upon the minute character of the phenomena he is obliged to examine. These objections can only proceed from or have weight with those geologists of the old school who deliberately ignore physical science of every kind, and trust to the evidence of their hands and feet, their eyes,

noses, and other unaided senses, as the ultimate authority to which every question, however delicate or complicated, is to be referred.

Mr. Sorby has disposed of these field geologists in such a masterly manner that I cannot do better than quote his words :—

"And here I cannot but make a few remarks, in conclusion, on the value of that instrument [the microscope], and of the most accurate physics in the study of physical geology. Although with a first-rate microscope, having an achromatic condenser, the structure of such crystals and sections of rocks and minerals as I have prepared for myself with very great care, can be seen by good daylight as distinctly as if visible to the naked eye, still, some geologists, only accustomed to examine large masses in the field, may, perhaps, be disposed to question the value of the facts I have described, and to think the objects so minute as to be quite beneath their notice, and that all attempts at accurate calculations from such small data are quite inadmissible. What other science, however, has prospered by adopting such a creed? What physiologist would think of ignoring all the invaluable discoveries that have been made in his science with the microscope, merely because the objects are minute? What would become of astronomy if everything was stripped from it that could not be deduced by rough calculation from observations made without telescopes? With such striking examples before us, shall we physical geologists maintain that only rough and imperfect methods of research are applicable to our own science? Against such an opinion I certainly must protest; and I argue that there is no necessary connexion between the size of an object and the value of a fact, and that, though the objects I have described are minute, the conclusions to be derived from the facts are great."

IRISH GEOLOGICAL SURVEY.

The progress made in the Geological Survey of Ireland, under the superintendence of Mr. Jukes, during the past year, has been very considerable.

The survey on the six-inch scale is complete as to the counties of Dublin, Wicklow, Kildare, Carlow, Wexford, Waterford, Cork, and Kerry; and is largely advanced in Clare, Tipperary, and Queen's County; portions of King's County and Meath have also been surveyed. The publication of the one-inch maps, geologically coloured, is proceeding rapidly; of the 205 sheets into which all Ireland is divided, 44 were published at the close of 1858, and 37 others are more or less advanced, some of them being now in the colourers' hands. We may reasonably hope to see by the close of this year, or early in 1860, a total of 87 sheets published, rather more than two-fifths of the island. This area will comprise all the southern part of Ireland, south of the parallel of Nenagh, and all south of the parallel of Balbriggan, for a width of three sheets from the eastern coast.

During the past year, there were also published by the Geological Survey, to accompany the maps, four small descriptive pamphlets, entitled "Data and Descriptions," explanatory of four of the published

sheets. These are to be continued under the title of "Explanations," and it is intended to bring out one for each sheet. They contain descriptions of the physical geography, of the relations between the physical geography and the geological structure of the ground included in each sheet, a description of the rocks, and notes on the fossils contained in them, and also an abstract of the observations made in the field, being the data on which the conclusions as to the geological structure were founded. Two of these "Explanations" refer to the Kilkenny coal-field, and are now in the press, while others are in preparation. They will form a novel, attractive, and useful addition to the Geological Maps; and it is to be hoped that they will be issued with the Maps without additional charge, as they form an integral portion of the coloured maps, and are absolutely necessary to a perfect understanding of them.

MESSRS. DARWIN AND WALLACE ON VARIATION OF SPECIES.

During the course of last year two papers were laid before the Linnæan Society, which have so important a bearing upon geology, that a passing notice of them is necessary. One is by Mr. C. Darwin, "On the Variation of Organic Beings in a state of Nature; on the Natural Means of Selection; and on the Comparison of Domestic Races and True Species." The other paper is by Mr. Alfred Russel Wallace, "On the Tendency of Varieties to depart indefinitely from the Original Type." These papers are vouched for by two sponsors, Sir Charles Lyell and Dr. Joseph D. Hooker. I should not have paid much attention to them, or noticed them in this address, were it not evident that they are supposed by a certain class of geologists to prove more than they pretend, and to lead to conclusions which are rather hinted at than asserted. If they are of any value for a purpose beyond what appears to be their intention, it can only arise from the supposition that they go far to prove the doctrine of Transmutation of Species, a doctrine which appears to disturb the speculations of some geologists and naturalists as much as the Transmigration of Souls afflicted the Pythagoreans, or the Transmutation of Metals the Alchemists of the Middle Ages.

Let us examine what is asserted, and what is proved, by Mr. Darwin.

Mr. Darwin's paper is simply an application of Malthus's doctrine of population to organic species, and a consequent demonstration that none but the healthiest, the most vigorous, and the best provided of a species can survive; and that the weakest must 'go to the wall.' The result of this battle of life will be, that a race or variety of the species will be propagated, more intelligent, more capable of securing its food, than the other races; and that there will be no tendency to return to the original type if that type were less skilful and active than the variety into which it has passed by breeding. To this there can be no objection, except that of want of novelty.

Mr. Wallace, in his paper, adopts the same line of reasoning, and carries it one step farther, as appears from the following passage:—

"We believe we have now shown that there is a tendency in nature

to the continued progression of certain classes of *varieties* further and further from the original type—a progression to which there appears no reason to assign any definite limits—and that the same principle which produces this result in a state of nature will also explain why domestic varieties have a tendency to revert to the original type. The progression, by minute steps, in various directions, but always checked and balanced by the necessary conditions, subject to which alone existence can be preserved, may, it is believed, be followed out, so as to agree with all the phenomena presented by organized beings, their extinction and succession in past ages, and all the extraordinary modifications of form, instinct, and habit which they exhibit."

The possibility of departing *indefinitely* from the original type is here assumed, and must be regarded as an hypothesis contrary to our experience, and at variance with all we know of other departments of nature.

It does not follow, because we can bend a bow a certain distance without its breaking, that therefore we may safely apply to it any force; neither does it follow, that because the individuals of a certain variety of species are capable of living on under circumstances of privation and trial that would destroy their weaker brethren, that therefore they would survive any amount of change, by becoming accommodated to the new conditions. According to the law on which the Creator has formed the universe, it appears to me that the propagation of special varieties is simply a provision to guard against the destruction of the species by any, the least, change; and that it is unphilosophical in the highest degree to assume an unlimited amount of change to be possible.

This speculation of Messrs. Darwin and Wallace would not be worthy of notice, were it not for the weight of authority of the names under whose auspices it has been brought forward. If it means what it says, it is a truism; if it means anything more, it is contrary to fact.

ASTRONOMICO-GEOLOGICAL SPECULATIONS.

Several questions, of astronomical rather than geological interest, have received the attention of physical investigators during the year, particularly the question of the fluid condition of the interior of the earth, respecting which Professor Jellett and Professor Hennessy have published their views. Before entering on this subject, it may be worth while to express my own views as to its bearing on, and relation to, geological inquiries.

There are four distinct periods or epochs, plainly recognisable in the history of our globe, viz.:—

1. The Astronomical.
2. The Cosmogonical.
3. The Geological.
4. The Historical.

The first of these, or Astronomical, involves the consideration of the earth considered as part of the solar system, and includes the discussion

of various theories as to the origin and phenomena of that system, such as the nebular hypothesis, the nature of comets, the relation of our system to other stellar systems, and such like questions. These inquiries are universally admitted to be *not geological.* The second epoch of our globe embraces the transition period from the Astronomical to the Geological; during this period no life existed on the earth, but the great outlines of the physical structure of the globe were laid down, and many of the depressions and elevations frequently referred by geologists to secondary and tertiary epochs were probably in existence before the first creature of God lived upon the face of the earth. The tidal currents followed their present laws, arising from the configuration of the primeval valleys of the bottom of the sea, and the skeleton framework of the great continents was constructed during this cosmogonical period. I do not deny that we may find traces of elevation and depression belonging to subsequent or geological periods, but they were all subsidiary movements taking place along the lines of ancient lines of elevation, which, we have every reason to believe, were marked out before a single zoophyte spread his branches to the currents of the tidal wave, or before a single crustacean crawled or jumped on the palæozoic sea-beach. Thus, in order of time, as in degree of importance, the physical laws of the universe preceded the organic, and the earth was prepared for the habitation of God's creatures before they were called by His word into being.

The third, or Geological Epoch, succeeded the Cosmogonical, and in it we find the earliest traces of life on our globe. It is as false in philosophy as it would be irreverent in religion to assert, that "the world shows no traces of a beginning, no prospect of an end;" and it is as great an error as we can commit in Geology to suppose that we do not see the beginning of organic life in the strata exposed in the crust of the globe. For ages the prejudice prevailed that the Historical period, or that which is coeval with the life of man, exhausted the whole history of the globe. Geologists removed that prejudice, and proceeded to substitute another in its place—viz., that geological time is coeval with the globe itself, or that organic life always existed on its surface. I can see no difference in the two prejudices: they are equally unworthy of our attention; for as surely as God made Adam, so surely did he make the first creature, whatever it was, that crawled, or swam, or walked, or flew, on the surface of the globe.

Having thus divided the Cosmogonical from the Geological epoch, I shall now proceed to notice some speculations which have hitherto, but erroneously, as I think, been supposed to have had a bearing on Geology.

It is now many years since Mr. Hopkins published his two papers on the "Influence of the existence of a Fluid Nucleus on the Phenomena of Precession and Nutation." So many opinions have been expressed since that time on this subject, and so diverse in their tendency, that perhaps I may be pardoned if I here give a short history of this essentially cosmogonical problem.

In Mr. Hopkins' first paper the fluid nucleus and solid shell are

supposed both homogeneous, both elliptical and similar, with no relation between their densities; and the phenomena of precession and nutation are investigated on the supposition that the axes of rotation of the shell and nucleus differ from each other. The result of the investigation is, that the Lunisolar Precession is the same as if the whole earth were solid. In his second paper Mr. Hopkins assumes Laplace's hypothetical law of density (for which there is no shadow of evidence), and the heterogeneity of the crust and nucleus, both subject to this law. The inner and outer surfaces of the shell are now, of course, no longer similar to each other, and there is assumed no law of connexion between the densities of the shell and nucleus. So far, every assumption is legitimate, except the arbitrary one of Laplace's law. The result is, that to give the observed Lunisolar Precession, the shell must have a thickness of from 800 to 1000 miles.

The problem is purely mathematical, and if we had assumed any other law of density, we should have found another thickness just as improbable and arbitrary as that found by Mr. Hopkins.

The next labourer who appeared in this investigation was Professor Hennessy, who has endeavoured to find *two* limits to the thickness of the shell, by adopting the following hypotheses:—

1st. By assuming Laplace's law to hold good for the nucleus and shell, with an abrupt alteration of constants in passing from the shell to the nucleus, to correspond with a supposed and probable change in density in passing from the liquid to the solid condition, Mr. Hennessy obtains a major limit to the thickness of the shell of 600 miles. His minor limit is founded on the following hypotheses:—

a. The shell homogeneous, and of the density of the rocks at the surface.

b. Inner and outer surfaces of shell *similar*.

c. Internal surface perpendicular to gravity.

d. Outer surface not perpendicular to gravity, and its ellipticity, if it were so, $\frac{1}{284}$, instead of $\frac{1}{300}$.

From these assumptions Mr. Hennessy finds the thickness of the shell to be eighteen miles, a result which has been frequently quoted by geologists as falling in with their preconceived views of what the thickness ought to be.

I do not regard Mr. Hennessy's hypotheses as entitled to more weight than Mr. Hopkins', with which, so far as Laplace's law is concerned, they are identical; and in a paper published by me in the "Transactions of the Royal Irish Academy," on the "Original and Actual Fluidity of the Earth and Planets," I have endeavoured to show that all such speculations are only to be received with the credit due to the truth or probability of the hypotheses on which they are based. I confess that I have a strong objection to one of Professor Hennessy's hypotheses, that, namely, which assumes the outer shape of the earth not to be perpendicular to gravity. So far as we know, the results of direct measurement and observations on the moon (with which latter the pendulum result *should* be identical) both give $\frac{1}{300}$ as the true figure of the earth. It is true the pendulum gives $\frac{1}{288}$, and Mr. Hennessy assumes

$\frac{1}{294}$, the mean of both, as the true figure perpendicular to gravity; but in my opinion the pendulum result is influenced by local attractions, such as the ocean, special geological formations, &c., and not entitled to the same weight as the lunar observations, which are theoretically equivalent, and which latter give the same shape, $\frac{1}{300}$, that Bessel deduced from the direct measurement of arcs.

But even granting Mr. Hennessy's hypothesis, that the outer surface of the shell is not perpendicular to gravity, it appears to me that there is an error in his calculation of the thickness of the shell, which, admitting his hypotheses, should, if my calculation be correct, be 166 miles, instead of 18 miles, as I have shown in the paper referred to. This minor limit to the thickness of the shell, of course, destroys the supposed geological interest of the question; but I should be sorry to rest the question on a mere numerical calculation, as, in my opinion, the principle is fundamentally erroneous which would seek to support geological theories as to volcanic phenomena, or igneous action of any kind, by appealing to speculations which belong essentially to the Cosmogonical, and not to the Geological, epoch of our globe. Mr. Hopkins has appealed to the motion of the moon, Mr. Hennessy to the phenomena of gravity, and both have raised questions of the highest interest to the mathematician; but, in my opinion, destitute of any practical bearing on the science of Geology.

Quite recently, Professor Jellett has added to our knowledge of this subject, by calculating the change in the length of the day that would be produced by the friction of the nucleus against the shell. His solution of this question is independent of the homogeneity or heterogeneity of the shell, and to a certain extent of its ellipticity. His result is, that the change in the length of the day would be imperceptible in 3000 years.

So far as the investigations of mathematicians have proceeded as yet, the result seems to be as follows:—

1st. That the earth; land, water, and sea bottom, considered as a whole,—or, if we please, the couche ten miles down,—of equal density, has assumed a mean shape, of the ellipticity of $\frac{1}{300}$.

2nd. That the force of gravity is, and must be, everywhere perpendicular to this surface.

3rd. That if friction be allowed to exist between the nucleus and shell, there is no minor limit, and no major limit, possible to the thickness of the latter; for the whole may be fluid, and yet move as a solid.

4th. That particular plains and tracts of the earth's surface may possess a shape different from that represented by the ellipticity of $\frac{1}{300}$.

5th. That no conclusion, of geological value, can be drawn from these speculations as to either the fluid nucleus of the earth or the changes its shape has already undergone.

THEOLOGICAL THEORIES OF GEOLOGY.

Before concluding, I would say a few words on a remarkable book which has given rise to much discussion, both outside and inside geolo-

By separate experiments it was ascertained that the combined silex was associated exclusively with the zinc, for the loose red powder contained nothing but peroxide of iron and water. Such being the case, it seemed highly probable that the crystalline material was the ore of zinc, well known under the name of electric calamine, and this anticipation was converted into a certainty when, in discussing the analytic results, it was ascertained that for every atom of combined silex there were three atoms of oxide of zinc, and that the water found was almost exactly the quantity necessary for bringing the silicate of zinc and the peroxide of iron to the hydrated condition. In fact, the results already obtained may be made to assume the following form, viz. :—

(1)	Silex,	19·72
	Oxide of zinc,	54·00
	Water,	5·79
(2)	Peroxide of iron,	15·30
	Water,	3·01
	Sand,	1·58
	Sulphide of lead,	0·60
		100·00

The results in group (1) correspond exactly to $2(3ZnO, SiO_3) + 3HO$, the well-known formula for electric calamine; and those in group (2) very nearly to $2Fe_2O_3, 3HO$, the formula of brown Hematite.

As respects the precise locality in which this mineral is found, my information, I regret to say, is rather scanty, being derived solely from the following passage in a letter which I received, on the 15th of January, from Mr. Gartlan :—

"The portion of earth sent to you for analysis was taken from the bottom of an old shaft on the property of the General Mining Company for Ireland, at Silver Mines, in the county of Tipperary. This shaft had been sunk, some years ago, by former lessees of the mine, but was afterwards abandoned."

Should an ore such as that I have just described, containing 54 per cent. of oxide of zinc, equivalent to 43·33 per cent. of metal, be found in quantity in the Silver Mines, it would undoubtedly be a discovery of commercial importance. It is true, the electric cannot be smelted with the same facility as ordinary calamine, as the oxide of zinc does not admit of being reduced while it is in union with the silex. This difficulty, however, may be easily overcome by the use of a proper amount of some strong base, such as lime, which will, at an elevated heat, set the oxide of zinc free, when this latter will, as usual, be deoxidized by the carbon. It is a curious fact, that this obvious modification of the smelting process, as usually practised, has not as yet come to be adopted on a great scale in either England, Belgium, Silesia, or Bleiberg,—the mixed ores, after having undergone a preliminary roasting, being still heated, with a view to their reduction, in contact with charcoal alone. The result,

WEDNESDAY EVENING, MARCH 9, 1859.

REV. PROFESSOR HAUGHTON, F.T.C.D., F.R.S., President, in the Chair.

THE Minutes of last Meeting having been read, were approved of, and signed by the Chairman.

Laurence Waldron, LL.D., M.P., Ballybrack, proposed by Dr. Apjohn, and seconded by Gilbert Sanders, Esq., was declared duly elected.

JAMES APJOHN, M.D., Professor of Chemistry in the University of Dublin, read a paper—

ON THE OCCURRENCE OF ELECTRIC CALAMINE AT THE SILVER MINES, COUNTY OF TIPPERARY.

IN January last I received from Mr. M'Evoy Gartlan, a gentleman who has, I understand, some interest in the Mining Company of Ireland, a mineral substance for analysis, which turns out to be an ore well known to mineralogists and chemists. It is, however, the first specimen having an Irish locality which has come under my observation; and I do not find, in any book to which I have had access, mention made of its occurrence in this country. Under these circumstances it has occurred to me that it would be desirable to have the fact of its having been found in Ireland put upon record, and, with the view of securing such object, there is probably no better course to take than to bring what I know respecting it under the notice of the Geological Society.

This mineral substance, as it reached me, occurred in loose rounded masses, having at first sight the appearance of an ochrey clay. A little examination, however, showed that it was in the greater part a colourless crystalline mineral, encompassed by and intermixed with hydrated peroxide of iron. Distinct crystals were not easily obtained, but a well-developed one, of moderate size, was finally picked out, which, when examined under the microscope, proved to be a trimetric prism, terminated by the faces of the two horizontal prisms characteristic of the fourth system.

Preparatory to its analysis a known weight of it, including not only the crystalline material, but the loose ochrey coating, was heated for some time at 212°, and found to lose 5·23 per cent. of water. The dry residuum was then made the subject of experiment, and was found to include the following constituents:—

Siliceous sand,	1·58
Silex, which gelatinized,	19·72
Oxide of zinc,	54·00
Peroxide of iron,	15·30
Water,	8·80
Sulphide of lead,	0·60
	100·00

By separate experiments it was ascertained that the combined silex was associated exclusively with the zinc, for the loose red powder contained nothing but peroxide of iron and water. Such being the case, it seemed highly probable that the crystalline material was the ore of zinc, well known under the name of electric calamine, and this anticipation was converted into a certainty when, in discussing the analytic results, it was ascertained that for every atom of combined silex there were three atoms of oxide of zinc, and that the water found was almost exactly the quantity necessary for bringing the silicate of zinc and the peroxide of iron to the hydrated condition. In fact, the results already obtained may be made to assume the following form, viz. :—

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however, of such imperfect process is, that the loss of metal is enormous, amounting, according to Dumas, to 25, and, according to Millar, to 50 per cent. A portion of this loss is, no doubt, due to the partial oxidation of the vaporized metal, but the greater part must be referred to the fact that silicate of zinc is not reducible by charcoal unless a strong base be also present.

I may, in conclusion, observe, that along with the electric calamine, and mixed with it, I received from Mr. Gartlan another substance, including a much smaller quantity of silicate of zinc, and a larger amount of the hydrated peroxide of iron, mixed with sulphide of lead—this latter constituting about one-twentieth of the weight of the entire. This galena was examined for silver, and, according to a single experiment, very carefully made, it was found to be highly argentiferous, including about eighty ounces of silver to the ton.

The President having left the Chair, it was taken by the Rev. Professor Galbraith.

The Rev. Samuel Haughton, President, then read the following paper—

ON THE FELSPAR AND MICA OF THE GRANITE OF CANTON.

The granite of the neighbourhood of Canton is composed of gray quartz, a light flesh-coloured or creamy-white felspar, in large crystals, and a black glossy mica (crystals $\frac{3}{4}$ by $\frac{1}{2}$ inch) imbedded in the felspar, and accompanied by quartz.

The following analyses will show the chemical character of these minerals:—

Felspar of Canton Granite.

	Per Cent.	Atoms.	
Silica,	64·48	1·433	
Alumina,	19·12	0·367	0·374
Peroxide of iron,	0·56	0·007	
Lime,	0·45	0·016	0·386
Magnesia,	trace		
Potash,	12·52	0·266	
Soda,	3·24	0·104	
Loss by ignition,	0·16		
	100·53		

From the preceding analyses may be deduced the following relation among the atoms of silica, peroxides, and protoxides:—

Silica,	1433	4·00
Peroxides,	374	1·04
Protoxides,	386	1·08

From which it is plain that this felspar is Orthoclase.

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The mineralogical formulæ of the four minerals are :—

I. *Lepidomelane:*

$$\left[\frac{25}{100}(3\,RO) + \frac{75}{100}(R^2\,O^3)\right]SiO^{3\,\frac{11}{10}}.$$

II. *Black Mica of Carlow:*

$$\left[\frac{23}{100}(3\,RO) + \frac{77}{100}(R^2\,O^3)\right]SiO^{3\,\frac{12}{10}}.$$

III. *Black Mica of Donegal:*

$$\left[\frac{21}{100}(3\,RO) + \frac{79}{100}(R^2\,O^3)\right]SiO^{3\,\frac{12}{10}}.$$

IV. *Black Mica of Canton:*

$$\left[\frac{26}{100}(3\,RO) + \frac{74}{100}(R^2\,O^3)\right]SiO^{3\,\frac{9}{10}}.$$

It appears to me that the preceding formulæ, representing black micas from Russia, Ireland, and China, balance around a mean or average formula, which may be regarded as the type species of this mineral, viz. :—

$$\left[\frac{25}{100}(3\,RO) + \frac{75}{100}(R^2\,O^3)\right]SiO^3.$$

This abstract or theoretical black mica probably exists only as an idea or conception in our minds, and may not have a concrete development in any place; but it must be regarded as an essential constituent of the original granite formed in the astronomical epoch by the cooling of our globe. All our researches tend to prove that there is an original or type-granite, characteristic of the azoic epoch of the earth's history, marked mineralogically by the presence of four important minerals:

1. Quartz;
2. Orthoclase felspar;
3. Black mica;
4. White mica;

and marked chemically by the abundance of potash and the absence of lime.

Donations were announced, and thanks voted to the donors. The Meeting then adjourned.

we are then met with another difficulty. About Milverton there are thick, massive, gray limestones, without any black shales, and somewhat similar limestones may be seen at the Naul and Flemingstown, apparently occupying a distinct band of country, of a width of from a quarter to half a mile between the Cambro-Silurian rocks and the upper shaly parts of the Carboniferous Limestone. The dip is south at low angles, so that there is apparently a thickness of 600 or 700 feet of these pure limestones.

Just about Bog of the Ring, however, there is a marshy flat of hardly a quarter of a mile in width; north of this the ground is all Silurian, but south of it nothing is to be seen but Carboniferous black shale, and black shale makes the whole of the high ground, for two miles south of it, as far as the Nag's Head. These shales seem to be in immediate contact with the Silurian rocks to the north of Bog in the Ring. What, then, has become of the thick group of pure gray limestone, which on each side of this locality forms a well-marked band of country between the Cambro-Silurian district and the Carboniferous black shales?

Mr. Dunoyer and I were engaged in endeavouring to solve this problem in the early part of this year, and had formed one or two hypotheses to account for the facts, which we proposed to lay before the last meeting of the Society. The week before the meeting, however, he took me to a small quarry at the top of the hill of Westown, a little south of the Naul. It so happened that I had been the preceding week in the Queen's County and Kilkenny, examining the lower Coal-measure shales of that district, and, therefore, had their peculiar lithological characteristics fresh in my eye, and I was instantly struck with the similarity of these black shales at Westown to those I had recently been observing to the southward. These shales are black, hard, and splintery, and lie in regular layers of one or two inches thick, so as to have a peculiarly "banded" appearance when viewed *en masse*. They are generally iron-stained when weathered. Their peculiar character is constant over the northern part of the county of Cork, in the counties of Kerry, Limerick, Tipperary, Kilkenny, Queen's County, and Carlow. Their appearance in a cutting or quarry is very distinct from that of any shales interstratified with the limestone that I have seen; and in the counties just mentioned, where Coal-measure shales occur, no one familiar with those shales would do otherwise than class those seen at Westown as Coal-measure shales, unless good evidence could be shown to the contrary.

In all the counties just mentioned these shales abound occasionally in small crushed Goniatites, and in shells belonging to the genera Aviculopecten and Posidonomya. The same abundance of these fossils is to be found at Westown and the neighbourhood, and some of the other places where these Coal-measure shales occur in the northern part of the county of Dublin.*

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* Mr. W. H. Baily informs me that the fossils hitherto collected by us at Westown belong to the following species:—*Goniatites crenistria* and *Listeri* (?); *Aviculopecten*

While, however, I feel little or no hesitation in looking on these shales as being above all the beds of the Carboniferous Limestone and belonging to the group which we colour on the map of the Geological Survey as Coal-measures, I would, nevertheless, wish to record, in the most distinct manner, my decided opinion, *that no coal will ever be found in them*. The greatest thickness of these lower Coal-measure shales, in the northern part of the county of Dublin, does not exceed 500 feet. Now in all the counties of the south of Ireland, where we have hitherto examined the Coal-measure group, we have found that there is a thickness of at least 1000 or 1200 feet between the *lowest* little bed of coal and the top of the limestone, and that no *workable* beds of coal make their appearance in the coal-measures until the limestone is covered by at least 1400 or 1500 feet of shales, &c.

In the Castlecomer coal-field, the nearest to the county of Dublin, the thickness of about 1200 feet below the lowest coal is roughly divisible into two sub-groups, of about 600 feet each,—the uppermost containing many beds of sandstone and flagstone, while the lower consists almost entirely of black shales. I believe the black shales of the county of Dublin to belong to this lower sub-group only, and that the Coal-measure group nowhere rises high enough to take in the flagstone series, much less the still higher productive Coal-measures.

On one side of the Nag's Head patch of Coal-measures there come in two or three beds of hard sandstone, as at the Ballyrickard quarry, south of Bog in the Ring. These, however, lie immediately above the uppermost bed of limestone, and mark the base of the Coal-measure group. As might be expected, they are entirely of local occurrence.

The other places where these lower Coal-measure shales make their appearance are, one at Baldongan running out to Loughshinny, and some little patches which are visible on the shores, two in Loughshinny Bay, and one south of Drumanagh, and another south of the Giant's Hill. To the west they also cap a slightly elevated ground called Prospect Hill, and the Hill of Garristown.

If these be indeed the true Coal-measure shales, it follows that below their base is the Upper Limestone, and that, whatever may be the subdivisions into which it may be advisable to group the Carboniferous limestone of the county of Dublin, we have the upper limit of it marked out for us by the basal boundary line of these shales.

How far it may be possible to recognise the four subdivisions of, 4, Upper Limestone; 3, Calp, or Middle Limestone; 2, Lower Limestone; and 1, Lower Limestone shale,—which exist in other parts of Ireland, I am not yet prepared to determine. It is, however, pretty clear that in the county of Dublin any one of those subdivisions, or even the Coal-measures themselves, may form the local base of the Carboniferous

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papyraceus and *variabilis; Posidonomya Becheri;* and a small one like *membranacea* of M'Coy.

Besides these are undetermined species of the genera Lunula-cardium, Orthoceras, Dithyrocaris, Encrinites, and some stems and roots of plants.

GENERAL MEETING, WEDNESDAY, APRIL 13, 1859.

SIR R. GRIFFITH, BART., LL. D., in the Chair.

THE Minutes of last Meeting having been read, were approved of, and signed by the Chairman.

J. BEETE JUKES, M. A., F. R. S., read the following paper—

ON THE OCCURRENCE OF SOME ISOLATED PATCHES OF THE LOWER COAL-MEASURE SHALES IN THE NORTHERN PART OF THE COUNTY OF DUBLIN.

I HAVE always felt great difficulty in understanding the structure and arrangement of the Carboniferous rocks of the county of Dublin.

They are bounded on the south by Cambro-Silurian slates and Granite; about Howth they rest on Cambrian rocks; while near Portrane and Skerries, and along their northern boundary, they have again Cambro-Silurian rocks around them. Old Red Sandstone shows itself near Donabate, between the Limestone and the Cambro-Silurian, and there is a small patch of Old Red on Lambay Island. Everywhere else that formation seems to be entirely wanting, and the Carboniferous rocks appear to rest directly on the rock below, whatever it may be.

Along their southern margin the accumulation of drift is too great for us to say exactly what are the relations of the rocks; but, when first seen, the Carboniferous rocks, consisting of dark limestones with interstratified black shales, dip invariably south, or *towards their boundary, and towards the granite hills which rise up from below them.*

Over a certain space, near Belgarde Castle, the limestone becomes both lithologically and in its fossil contents like the Upper Limestone of Carlow and Kilkenny, but it dips south under some dark limestones with interstratified black shales, such as are not known elsewhere in or over the Upper Limestone.

At Howth there are a few beds, at Poulscadden Bay, which may be referred to the Lower Limestone shale group, but these are very thin, and do not always show themselves between the Cambrian rocks and the massive gray limestones. On the shore south of Malahide, however, immediately north of the "Velvet Strand," a much greater thickness of flaggy shaly limestone is seen, which, both lithologically and in fossil contents, is very like the Lower Limestone shale group, and it dips under a very considerable thickness of limestone between it and Malahide. But then this Lower Limestone shale appears to be far removed from the boundary of the formation, and if it be indeed the basal part of the Carboniferous formation, it is not easy to understand why it appears on the Malahide shore, especially as it does not show itself in the interior of the country towards which it strikes. There is little or no appearance either of these beds over the Old Red Sandstone of Donabate, though they may exist under the flat land that surrounds it.

The first beds that appear on the shore south of Rush may possibly belong to those beds, and there is then an ascending section to be seen

along the shore past Rush up to Lough Shinny Bay. The rocks are so much affected by flexures and contortions, and occasionally hidden under sandy strands, that it is impossible to arrive at any accurate estimate of their thickness, but it is clear that it must be considerable, as much as a thousand feet at least. Groups of black shale, as much as fifty or sixty feet in thickness, come in at one or two places over these limestones, and seem to be the highest visible beds. The rocks are not only wonderfully contorted about Lough Shinny, but are also faulted, the faults in one place having become the repositories of metallic ores, some of which were formerly extracted at the Lough Shinny lead mines. North of Lough Shinny the limestone beds along the shore dip gently to the north or *towards their boundary*, which in this case may be seen in the Cambro-Silurian rocks of Shennick's Island. It is nearly opposite that island that the great conglomerates occur in the limestone; large and small, well-rounded lumps of slate, trap, and green grit, evidently derived from the Cambro-Silurian rocks, are here embedded in the limestone; layers of sand and pebbles also occur in the limestones, and in some places to such an extent that the limestone becomes almost converted into a sandstone. Well-rounded lumps of limestone, which from the crinoidal stems are evidently Carboniferous Limestone, also occur. Some of the blocks of Silurian grit are as big as a man's hand.

Similar conglomerates also show themselves at the point of the shore east of Rush, regularly interstratified with the limestones, and including blocks which near the little harbour of Rush may be seen to become as large as a man's body. Now at Rush there is a thickness of limestone *below* the upper bed of these conglomerates, of certainly not less than one thousand feet. If, then, those on the shore opposite Shennick's Island be on the same horizon, we should at first feel inclined to suppose that there must be a similar thickness below them there also, and there is nothing against such a supposition, except the fact that the conglomerates are there covered by other limestones, and *that they all dip towards* Shennick's Island, i. e. *towards the boundary of the formation*, retaining that dip as far as any beds are visible. If, therefore, there be that thickness and depth of limestone there, what are the circumstances that allow of the appearance of the Cambro-Silurian rocks of Shennick's Island at the surface, within so short a distance as 600 or 700 yards? Are we to suppose a sudden bend up of the beds, of which there is no trace visible? Are we to suppose a fault, or do the beds abut against an old Silurian cliff?*

Proceeding from Skerries westward into the interior of the country, we find at Milverton and other places, as far as Flemingstown, county of Meath, the Carboniferous rocks every where dipping in the direction we should expect, namely, towards the south, or from their boundary, but

* Mr. Hargrave, in a paper recently read before the Society, proposed to consider that the beds were inverted here,—a hypothesis which would, indeed, get rid of a difficulty in this particular locality, but leave the other difficulties alluded to in this paper still unexplained.

we are then met with another difficulty. About Milverton there are thick, massive, gray limestones, without any black shales, and somewhat similar limestones may be seen at the Naul and Flemingstown, apparently occupying a distinct band of country, of a width of from a quarter to half a mile between the Cambro-Silurian rocks and the upper shaly parts of the Carboniferous Limestone. The dip is south at low angles, so that there is apparently a thickness of 600 or 700 feet of these pure limestones.

Just about Bog of the Ring, however, there is a marshy flat of hardly a quarter of a mile in width; north of this the ground is all Silurian, but south of it nothing is to be seen but Carboniferous black shale, and black shale makes the whole of the high ground, for two miles south of it, as far as the Nag's Head. These shales seem to be in immediate contact with the Silurian rocks to the north of Bog in the Ring. What, then, has become of the thick group of pure gray limestone, which on each side of this locality forms a well-marked band of country between the Cambro-Silurian district and the Carboniferous black shales?

Mr. Dunoyer and I were engaged in endeavouring to solve this problem in the early part of this year, and had formed one or two hypotheses to account for the facts, which we proposed to lay before the last meeting of the Society. The week before the meeting, however, he took me to a small quarry at the top of the hill of Westown, a little south of the Naul. It so happened that I had been the preceding week in the Queen's County and Kilkenny, examining the lower Coal-measure shales of that district, and, therefore, had their peculiar lithological characteristics fresh in my eye, and I was instantly struck with the similarity of these black shales at Westown to those I had recently been observing to the southward. These shales are black, hard, and splintery, and lie in regular layers of one or two inches thick, so as to have a peculiarly "banded" appearance when viewed *en masse*. They are generally iron-stained when weathered. Their peculiar character is constant over the northern part of the county of Cork, in the counties of Kerry, Limerick, Tipperary, Kilkenny, Queen's County, and Carlow. Their appearance in a cutting or quarry is very distinct from that of any shales interstratified with the limestone that I have seen; and in the counties just mentioned, where Coal-measure shales occur, no one familiar with those shales would do otherwise than class those seen at Westown as Coal-measure shales, unless good evidence could be shown to the contrary.

In all the counties just mentioned these shales abound occasionally in small crushed Goniatites, and in shells belonging to the genera Aviculopecten and Posidonomya. The same abundance of these fossils is to be found at Westown and the neighbourhood, and some of the other places where these Coal-measure shales occur in the northern part of the county of Dublin.*

* Mr. W. H. Baily informs me that the fossils hitherto collected by us at Westown belong to the following species:—*Goniatites crenistria* and *Listeri* (?); *Aviculopecten*

While, however, I feel little or no hesitation in looking on these shales as being above all the beds of the Carboniferous Limestone and belonging to the group which we colour on the map of the Geological Survey as Coal-measures, I would, nevertheless, wish to record, in the most distinct manner, my decided opinion, *that no coal will ever be found in them.* The greatest thickness of these lower Coal-measure shales, in the northern part of the county of Dublin, does not exceed 500 feet. Now in all the counties of the south of Ireland, where we have hitherto examined the Coal-measure group, we have found that there is a thickness of at least 1000 or 1200 feet between the *lowest* little bed of coal and the top of the limestone, and that no *workable* beds of coal make their appearance in the coal-measures until the limestone is covered by at least 1400 or 1500 feet of shales, &c.

In the Castlecomer coal-field, the nearest to the county of Dublin, the thickness of about 1200 feet below the lowest coal is roughly divisible into two sub-groups, of about 600 feet each,—the uppermost containing many beds of sandstone and flagstone, while the lower consists almost entirely of black shales. I believe the black shales of the county of Dublin to belong to this lower sub-group only, and that the Coal-measure group nowhere rises high enough to take in the flagstone series, much less the still higher productive Coal-measures.

On one side of the Nag's Head patch of Coal-measures there come in two or three beds of hard sandstone, as at the Ballyrickard quarry, south of Bog in the Ring. These, however, lie immediately above the uppermost bed of limestone, and mark the base of the Coal-measure group. As might be expected, they are entirely of local occurrence.

The other places where these lower Coal-measure shales make their appearance are, one at Baldongan running out to Loughshinny, and some little patches which are visible on the shores, two in Loughshinny Bay, and one south of Drumanagh, and another south of the Giant's Hill. To the west they also cap a slightly elevated ground called Prospect Hill, and the Hill of Garristown.

If these be indeed the true Coal-measure shales, it follows that below their base is the Upper Limestone, and that, whatever may be the subdivisions into which it may be advisable to group the Carboniferous limestone of the county of Dublin, we have the upper limit of it marked out for us by the basal boundary line of these shales.

How far it may be possible to recognise the four subdivisions of, 4, Upper Limestone; 3, Calp, or Middle Limestone; 2, Lower Limestone; and 1, Lower Limestone shale,—which exist in other parts of Ireland, I am not yet prepared to determine. It is, however, pretty clear that in the county of Dublin any one of those subdivisions, or even the Coal-measures themselves, may form the local base of the Carboniferous

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papyraceus and *variabilis; Posidonomya Becheri;* and a small one like *membranacea* of M'Coy.

Besides these are undetermined species of the genera Lunula-cardium, Orthoceras, Dithyrocaris, Encrinites, and some stems and roots of plants.

series; or, in other words, may rest directly on the Cambro-Silurian, Cambrian, or Granite rocks, without the interposition of any of the other members of the Carboniferous group, which are to be found beneath them in other places.

We must, I think, seek for the explanation of this circumstance in the fact of the entire unconformability of the Carboniferous formation, taken as a whole, to the Lower Palæozoic formations, and in the overlap of the different members or subdivisions of the Carboniferous series among themselves.

The history of the deposition of the Carboniferous rocks of the county of Dublin was, probably, something like the following:—

In the first place, there was probably a dry land formed of the Granite mountains of Dublin, the Cambrian rocks of Howth, and the Cambro-Silurians which now show themselves at Portrane, at Lambay, and in the Balbriggan country. There was probably a broad valley between the Granite mountains on the south and the Cambro-Silurian hills on the north, with, perhaps, a connecting ridge now marked by Howth Hill and Lambay Island.

This land then commenced to be depressed, so that part of the lower central region sank beneath the sea. On the beach of this sea were deposited patches of sand and gravel, now forming the Old Red Sandstone of Donabate and Lambay Island.

This depression continued gradually, and sheet after sheet of limestone was formed at the bottom of the sea, which, as the land sank, ever spread wider and wider over it, and caused its deposits likewise to spread wider and wider over those which lay below.

The original land having been hilly and irregular, it would follow that the hills, as it sank, would be first made into promontories, then into islands and islets, and, at last, into mere rocks, until eventually they sank out of sight, and were buried under the ever-enlarging sheets of Carboniferous Limestone. Each of these islets and rocks, however, would, before being finally buried, be much battered and wasted by the waters of the sea, and become a local centre for the diffusion of shingle, sand, or mud; while large, rounded, or angular blocks would be strewed around it, or even, perhaps, washed and rolled along the sea bottom for some distance from it. The Cambro-Silurian rocks, especially, being themselves made so largely of black or dark clay-slate, would by their waste often muddy all the sea around them. We should, therefore, expect that near these shores the limestone would be throughout much more dark and earthy, and more characterized by the occurrence of black shales than in other places where the sea was more open, and farther removed from the washing of the land.

Finally, as the depression continued, and circumstances became unfavourable for the formation of calcareous matter, the Coal-measure shales and sandstones would spread over all the previously formed limestones, and even far beyond them, on to the hitherto uncovered ground of Cambro-Silurian, or any other rock.

I believe, indeed, that at the close of the Coal-measure period, the

whole of the south of Ireland, from the county of Dublin to Kerry and Cork, was one vast plain of Coal-measures (still, perhaps, below water), with none but the very loftiest peaks of what are now the Dublin, Wicklow, and Wexford mountains, uncovered by those Coal-measures.

Fig. 1. will represent this condition of the rocks of the county of Dublin.

After this time there commenced a period of disturbance, elevation, and denudation, so that the rocks became variously bent and broken, and very largely denuded; and this process was continued, and, perhaps, renewed and extended, from time to time, during subsequent geological periods, until eventually the present surface of the ground was produced, and the rocks left somewhat in the position represented in Fig. 2, which is intended as a rough sketch of a north and south section through the county of Dublin, from the Granite hills of the south to the Cambro-Silurian district in the north.

Fig 1

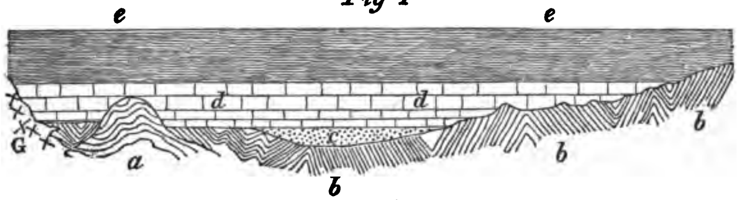
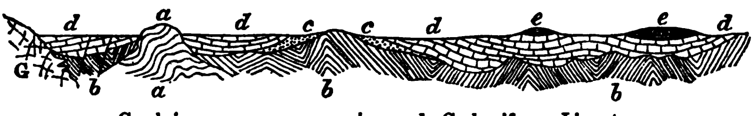


Fig 2



a, Cambrian.	*d*, Carboniferous Limestone.
b, Cambro-Silurian.	*e*, Lower Coal-measure shales.
c, Old Red Sandstone.	*G*, Granite.

Sir R. Griffith requested to be allowed to leave the Chair, which was then taken by Dr. Wright.

Sir R. Griffith then made some remarks on the paper, in which he dissented from some of the conclusions of Mr. Jukes.

Mr. Kelly also made some observations.

W. H. Baily, F. G. S., read a Paper—

ON THE OCCURRENCE OF DETACHED PLATES OF THE SHELL OF A NEW SPECIES OF CHITON IN THE CARBONIFEROUS LIMESTONE AT LISBANE, COUNTY OF LIMERICK.

The genus Chiton, established by Linnæus in 1758 to include a small number of recent species, which has now increased to more than 200,

was not so extensively represented in a fossil state, there being up to the present time only 39 fossil species recorded, a few of which are doubtfully referred to this family. Remains of this class are therefore comparatively rare, especially in the older formations of the British islands, and it is somewhat remarkable that Ireland should have furnished the two only examples met with in the United Kingdom from the most ancient Palæozoic deposits, viz., the *Helminthochiton Griffithii* described by Mr. Salter in Sir R. Griffith's "Silurian Fossils of Ireland," and the species I am about to describe, which was procured from the Carboniferous Limestone of Lisbane, county of Limerick.

The greater proportion of recorded species are from foreign strata; of these, seven are said to occur in Devonian, and eight in Carboniferous formations. The Permian deposits have been the most prolific in England, having yielded five or six species, which are described by Messrs. King, Howse, and Kirkby. A doubtful species is said to occur in the Bunter Sandstone of Germany; two species only have been recorded from strata of the secondary epoch: one from the middle Lias of Thionville; the other from the great Oolite of Langrune. Two species only are mentioned as occurring in foreign strata, of Lower Tertiary, or Eocene age; whilst ten have been found in Upper Tertiary deposits, of which five have been described from the English crag, and four others from foreign strata.

The sub-genus Helminthochiton was established by Mr. Salter in 1846* to include the interesting Silurian Chiton from Cong, county of Galway, before alluded to, described by him, from the collection of Sir R. Griffith, and figured in the Addenda to his Synopsis of the Silurian Fossils of Ireland (p. 71, Pl. v., Fig. 5). This, with some elongated forms of Carboniferous Chitons, to which our fossil is closely related, he groups under several sections, according to the form of the plates.

The following is a description of the species which is the immediate subject of this communication.

Family.—Chitonidæ.

Chiton Thomondiensis (*Baily*) (Plate IV., Fig. 2, *a–c*).

Shell elongated. Plates subquadrate and very thick, broader than long, having a median elevation, or prominent ridge, with an acuminated apex; surface concentrically striated by lines of growth, which

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* Professor De Koninck, celebrated for his knowledge of fossils from the Carboniferous formation, and an acknowledged authority on this class of fossil animals, is, however, of opinion that it does not differ by any essential character from the ordinary Chitons, and, therefore, does not adopt this generic name, which, he thinks, could only serve to denote a section of the genus Chiton.—"Observations on Two New Species of Silurian Chitons," "Bulletins de l'Academié Royale des Sciences, &c., de Belgiques," 26me annee, 2me ser., tome iii., 1857. By M. L. De Koninck, M. D., Professor of Chemistry and Palæontology in the University of Liége.

See also a paper by Mr. Salter on Fossil Chitons in "Proceedings of the Geological Society of London," vol. iii., part 1, June 17, 1846.

become broken into granulations on each side of the central ridge, about ten faint radiating lines proceeding from the apex to the posterior margin; apophyses widely separated.

Dimensions of largest Plate.

Breadth,	$1\frac{3}{10}$ inch.
Height,	$\frac{9}{10}$ "
Thickness,	$\frac{1}{8}$ "

Medium Plate.

Breadth,	$1\frac{2}{10}$ inch.
Height,	$8\frac{1}{2}$–16ths.

Smallest Plate.

Breadth,	$\frac{9}{10}$ inch.
Height,	$\frac{7}{10}$ "

Four detached intermediate plates of this magnificent fossil Chiton, with two fragments of what appears to be the under surface of its very thick shell, showing markings for the attachment of muscles, were found by Mr. C. Galvin, one of the fossil collectors of the Geological Survey, in the Carboniferous Limestone of Lisbane, county of Limerick.* These plates are larger than those of any described species, and must have belonged to a shell of between five and six inches long (see restoration, Fig. 2, *c*). Two of the plates are in beautiful preservation, their surfaces being ornamented with longitudinal and concentric striations, which are also partly granulated. The largest of the plates, from the incrustations on its surface, and the strong imbricated appearance caused by the lines of growth, probably belonged to a very old specimen; another large plate (nearly smooth) shows the great thickness of its fractured shell, which in one part is the seventh of an inch thick; a cast of its under surface exhibiting a deep excavation for muscular attachment.

This species is allied to the *Chiton gemmatus* of De Koninck, from the Carboniferous Limestone of Visé, being intermediate in form to that and *Chiton priscus* (*Münster*), from the Carboniferous Limestone of Tournay, and Devonian of Villmar; it is, however, I think, sufficiently distinct in character to constitute it a new species; I have, therefore, named it *C. Thomondiensis*, from the county of Limerick, in which it was found, having anciently formed a part of the province of Thomond.

The discovery of a fossil Chiton in the Carboniferous Limestone of Ireland, so closely allied to those found in Belgium, is an interesting fact confirmatory of Professor De Koninck's observations on the Distribution of Carboniferous fossils, more especially as it is associated with *Euomphalus Dionysii*, and other characteristic fossils undistinguishable from identical species, procured from the Carboniferous Limestone of Visé.

The following is a list of all the species of fossil Chiton at present known, from the oldest formation in which their remains have been found, up to the most recent fossiliferous deposit:—

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* I have since met with this species in a cutting at Rathkeale, on the Limerick and Foynes Railway.

Lower Silurian.

39\. Chiton (Helminthochiton) Griffithii (*Salter*). Cong, Co. Galway.

Upper Silurian.

38\. Chiton Wrightianus (*De Koninck*). Dudley.
37\. „ Grayanus (*De Koninck*). Dudley.

Middle Devonian.

36\. Chiton saggittalis (*G. & F. Sandberger*). Villmar, Nassau.
35\. „ corrugatus (*G. & F. Sandberger*). Villmar, Nassau.
cordiformis (*G. Sandberger*).
priscus (*G. Sandberger*, non *Münster ?*)
Sandbergianus (*De Rhyckholt*).
Considered by De Koninck to be one species.

34\. „ fasciatus (*G. Sandberger*) from Bronn's Index Palæontologicus.
33\. „ subgranosus (*G. Sandberger*) from Bronn's Index Palæontologicus.
32\. „ (*n. s.*) Plymouth (collection of Geological Survey, London).
Not included in De Koninck's list.

Upper Devonian.

31\. Chiton tumidus (*De Kon.*). Grund.
30\. „ lævigatus (*Fr. Ad. Roemer*). Grund.

Carboniferous Limestone.

29\. Chiton concentricus (*De Kon.*) Visé.
28\. „ gemmatus (*De Kon.*). Visé.
„ var. Mosensis (*De Rhy.*). Belgium.
„ viseticola (*De Rhy.*). Belgium.
„ legiacus (*De Rhy.*). Belgium.
„ eburonicus (*De Rhy.*). Belgium.
Considered by De Koninck to be one species.

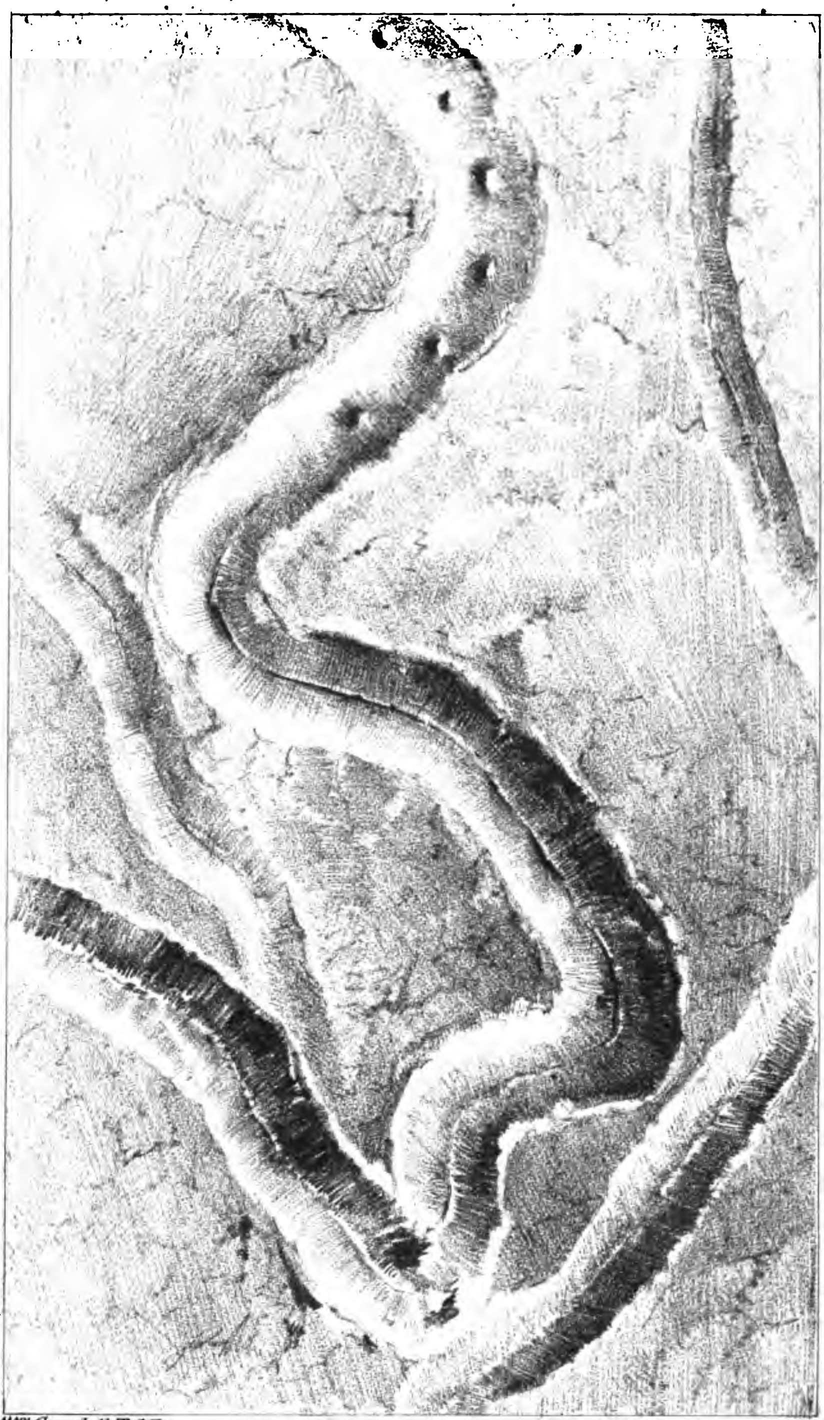
27\. „ „ priscus (*Münster*). Tournay.
26\. „ nervicanus (*De Rhy.*). Tournay.
25\. „ Turnacianus (*De Rhy.*). Tournay.
24\. „ mempiscus (*De Rhy.*). Tournay.
23\. „ Thomondiensis (*Baily*). Lisbane, and Rathkeale, Co. Limerick.
22\. „ (Chitonellus) cordifer (*De Kon.*). Tournay.

Permian.

21\. Chiton Loftusianus (*King*). Durham.
20\. „ Howseanus (*Kirkby*). Durham.
19\. „ ? cordatus (*Kirkby*). Durham.
18\. „ Hancockianus (*Kirkby*). Durham.
17\. „ distortus (*Kirkby*). Durham.
16\. „ antiquus (*Howse*). Durham.

Trias.

15\. Chiton ? Cottai (*Geinitz*). Bunter Sandstone.



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Lias.

14. Chiton Deshayesii (*Terquem*). Thionville.

Great Oolite.

13. Chiton Koninckii (*Eudes Deslongchamps*). Langrune.

Lower Tertiary, or Eocene.

12. Chiton antiquus? (*Conrad*). Alabama, N. America.
11. „ Grignonensis (*Deshayes*). Grignon, France.

Upper Tertiary.

10. Chiton transenna (*Lea*). Virginia, N. America.
9. „ subcajetanus Poli (*ex fide D'Orb.*). Turin.
8. „ { miocenus (*Michelotti*). Turin. / subappeninus (*Cantraine*). Turin.
7. „ strigillatus (*Wood*). "C. Crag," Sutton.
6. „ tenuisculptus (*Wood*). "C. Crag," Sutton.
5. „ arçuarius (*Wood*). "C. Crag," Sutton.
4. „ angulosus (*Wood*). "C. Crag," Sutton.
3. „ Rissoi (*Payrandean*). "C. Crag," Sutton
2. „ fascicularis (*Linnæus*). Sicily, Sutton.
1. „ siculus (*Gray*). Sicily.

M. Alphonse Gages, M.R.I.A., read the following Paper:—

ANALYSIS AND OBSERVATIONS ON SOME SEDIMENTARY ROCKS FROM THE CAPE OF GOOD HOPE, HAVING THE APPEARANCE OF SERPENTINE.

The two specimens which have been the subject of the following investigations form part of a collection made by Mr. Andrew Wyly at the Cape of Good Hope, and which has been sent by him as an illustration of his excellent Report upon the mineral and geological structure of South Namaqualand, and the adjoining mineral districts.

In this collection there are two varieties of rocks, presenting the appearance of Serpentine; and, as they scarcely differ in their chemical composition, I will merely give the description and analysis of one of them.

These rocks may be considered as belonging to that class of compounds called by such various names as Agalmatolite or Pagodite, Dysintribite, Parophite, &c., but which are in most cases nothing else than indurated clays, derived from the decomposition of felspathic or trachitic rocks.

The densities of the two specimens examined were 2·867 and 2·862, which nearly coincide with that given by Dufrenoy for Pagodite, which is 2·816. In composition they differ from that mineral; not, however, more than might be expected in the case of substances classified together for their general features, but derived from the chemical decomposition and mechanical alterations of various rocks.

I may describe the mineral having the density 2·867, as above stated, as an indurated clay, with a fine unctuous texture, being easily

worked and cut; its colour, seen in mass, is of a dull green, and acquires, when polished, a dark green colour, having golden-like spangles of mica disseminated through the mass; cut into thin plates, it becomes highly translucent, and acquires, when plunged into water, a beautiful leek-green colour.

The powder of the mineral, kneaded with water, possesses the plasticity of common clay, and can be fashioned in the same manner. It is partially affected by hydrochloric acid; the residue of clay left after the action of the acid is of a great tenuity, and, when diluted and stirred up in water, it is kept in a state of suspension for a long time. The first particles of clay deposited are accompanied by some minute debris of felspar, only recognisable with a lens.

The following is the analysis of the rock:—

Silica, by difference,	58·115
Alumina,	26·102
Iron, calculated as Fe_2,O_3,	8·593
Lime,	0·259
Magnesia,	0·248
Potash,	3·665
Soda,	0·345
Water,	2·673
	100·000

This analysis, as well as the mechanical examination of the mineral, leaves no doubt about its nature. It is evident that such rocks must present, also, very variable appearances, according to the circumstances of their deposition. I could refer to many analyses of impure Kaolin, Lithomarges, &c., which, although very dissimilar in physical appearance from many of the above-named rocks, have, nevertheless, a similar chemical composition.

In reference to these indurated clays, some of them, as the Parophite of Hunt, may be also derived from altered clay slates.

With the exception of Pagodite, which may be considered as a type, and which possesses a very distinct character, I do not see the advantage of distinguishing by new names products of such a similar nature as the rocks to which I have referred.

Mr. Jukes exhibited and explained a Diagram illustrative of the subdivision and expansion of the thick Coal of South Staffordshire.

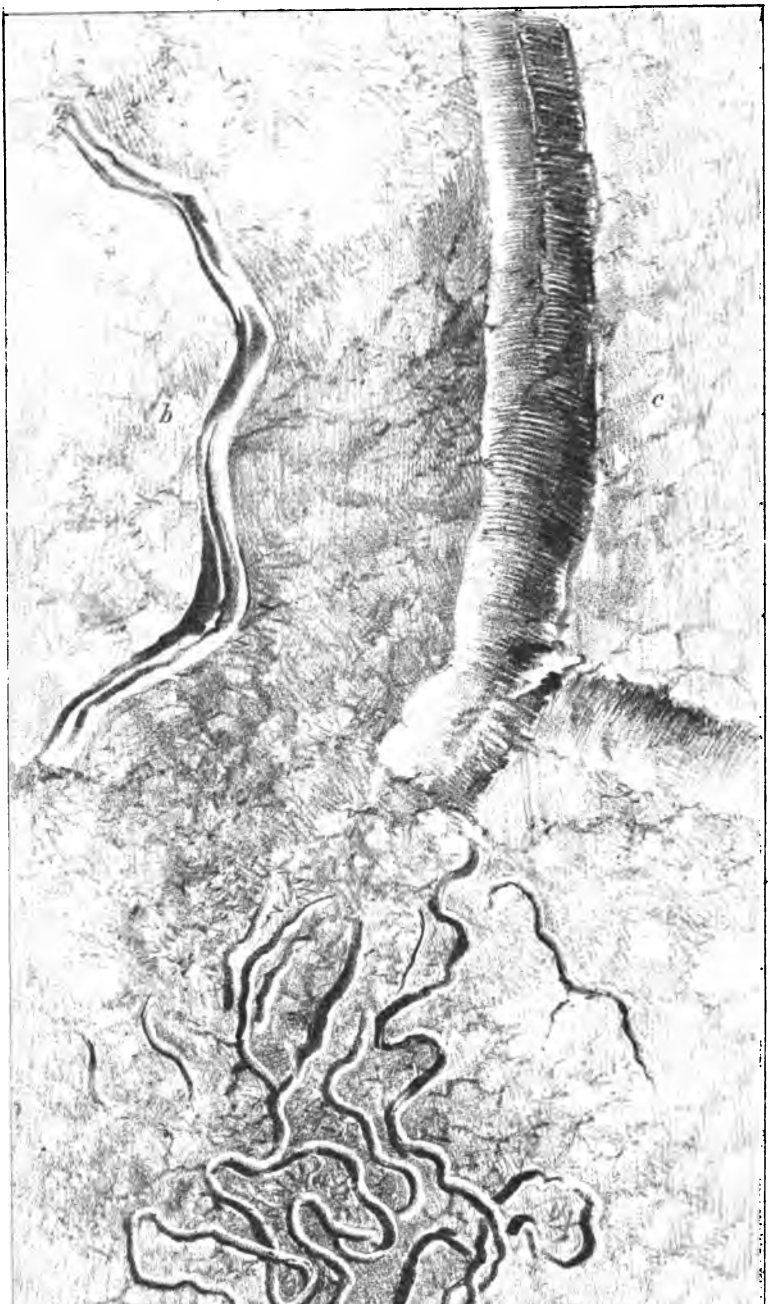
Donations were announced, and thanks voted to the donors. The Meeting then adjourned.

GENERAL MEETING, WEDNESDAY EVENING, MAY 11, 1859.

Rev. Professor Haughton, F.T.C.D., F.R.S., President, in the Chair.

The Minutes of last Meeting having been read, were approved of, and signed by the Chairman.

The following gentlemen were declared duly elected as Ordinary



Wm. Campbell T.C.D a

Members:—1. Michael J. O'Grady, Esq., 35, Blessington-street, proposed by G. M'Dowell, F. T. C. D., and seconded by the Rev. Professor Galbraith; 2. W. R. Wilde, M. R. I. A., 1, Merrion-square, North, proposed by the Rev. Professor Galbraith, and seconded by Dr. Apjohn.

Sir Richard Griffith, Bart., LL.D., &c., &c., read the following Paper:—

NOTICE OF AN ADDITIONAL PERMIAN LOCALITY IN THE COUNTY OF TYRONE.

The value of every local observation indicating the existence of any geological formation in a district or country, becomes increased in proportion to the infrequency with which opportunities of making it are presented, as, besides supplying a link in the general sequence, we are enabled by additional observation to infer in a certain degree the former continuity of such formation, as well as the probable amount of removal to which it has at some period been subject. With this view I am induced to bring forward a notification of the occurrence of some Permian strata which have not hitherto been recorded in Ireland, and, as our knowledge of the locality referred to is derived from a shaft lately made in search of coal, I am the more anxious to preserve a memento of the fact, owing to the comparative rarity with which such occasions of increasing our store of observations are afforded.

The fossils contained in the magnesian limestone rocks of Cultra, near Hollywood, in the county of Down, appeared to me to present a character so peculiar, that I submitted them, many years ago, to Professor M'Coy for examination, but, in consequence of some failure in their identification, the classification of these strata became a matter of some difficulty; and though it is true that their magnesian character has been recognised since the year 1835, as well as their similarity in lithological structure to the equivalent strata of Sunderland, it has only been since the year 1855 that they have been satisfactorily determined to belong to the lower New Red or Permian series, as will be seen upon reference to Professor King's paper, printed in our Journal, vol. vii., p. 57.

In the last edition of my Geological Map of Ireland an attempt has been made to subdivide the New Red Sandstone into an upper and lower series, but the data necessary for the purpose in my possession at the time was of too limited a character to effect more than an approximate subdivision, which, I trust, may, at all events, possess a suggestive value. In the paper before referred to, Mr. King has pointed out the circumstance of the yellowish limestone beds of Cultra being identified with those of Tullyconnell, in the neighbourhood of Artrea, in the county of Tyrone, and upon an examination of the fossils he has decided that both are undoubtedly referable to the true Permian formation as existing in the north of England, and elsewhere. It is so far satisfactory to possess the means of inferring the former continuation of these Permian rocks in a direct line for a distance of thirty-six miles from Cultra to Tullyconnell; but as in both localities we find the rocks ex-

posed only in two small quarries, it seemed desirable to observe its occurrence at other points, in order that we might form some probable idea as to its superficial extent, and it is information in reference to this that I would in the present communication endeavour to supply.

In the townland of Templereagh, immediately adjoining the Annaghone coal-field, which I formerly described as resting conformably in a basin of carboniferous limestone, having the beds of the New Red Sandstone unconformably overlying, a trial shaft has recently been sunk in search of coal, at a short distance south of the former workings, and south-east of the Templereagh corn-mill. By this trial, as far as it has gone, we are made acquainted with the following section, in descending order, for a distance of upwards of forty-five yards:—

1. 18 yards of blue clay or marl.
2. 5 feet of yellowish magnesian limestone, with cavities occasionally enclosing quartz.
3. 1 foot of red sandstone.
4. 3 yards of magnesian limestone, similar to No. 2, but of a reddish-yellow; also with cavities.
5. 2 inches of a hard parting.
6. 15 yards of soft brick red sandstone, with occasional alternating partings of soft red sandstone and gray slaty sandstone.

Upon continuing the trial about a yard further, the rock changed, but in consequence of the walls of the shaft (continued by boring) having given way some five yards higher up, or forty yards from the surface, it was abandoned, and another commenced on the rise of the dip, a little nearer to the bridge, north-west of the former, which is being still carried on.

In a section of the district which I published in the year 1829, extending from Tullyconnell on the north through the over-lying chalk and basalt of Stevenson's Dowery, and thence southward to the Carboniferous Limestone country of Drumagullion, I have represented the New Red Sandstone formation, resting unconformably on the coal-measures, as well as on the subjacent limestone beds, and dipping from them to the south,—a view which I find borne out by the sinking lately in operation, as the Permian strata dip to the south of east, at an angle of about 20°, while the coal-measures are found resting in a synclinal depression of the limestone, the dip being due north and south, at angles varying from 40° to 80°. It is not my present intention to enter into a detail of the geological structure of the country, but I may observe that the Permian rock lately found may possibly be an isolated outlier, as, in a former trial which I made for coal near the old ruin to the south-east, I succeeded in obtaining Carboniferous Limestone, which may consequently surround the Annaghone coal-basin and overlying Permian strata, both being intercepted by it from the main Triassic district lying to the south and east.

In the determination of the strata under consideration, it is to be regretted, that, so far, they appear to be non-fossiliferous, and, in conse-

quence, we are obliged to forego the valuable aid which such means of identification would afford; but if their lithological similarity to the undoubted Permian rocks, as at present defined, be taken into account, together with their equivalent geological position, and identity in chemical constitution, I think a case of sufficient certainty will have been established, by which to arrive at a definite conclusion in reference to their place in the general series.

The first of these characters, namely, their lithological similarity to the Cultra and Tullyconnell rocks, appeared to me to be so striking that, upon ascertaining their relative position, I entertained no doubt in regard to the series with which they should be associated; but, with a view of neglecting no available means of confirming my opinion, I had recourse to the assistance of our distinguished fellow-member, M. Alphonse Gages, the result of whose chemical examination of the specimens has justified the anticipation I had formed. M. Gages found that the principal constituent of the rock marked No. 2 in the above section consisted of a true magnesian limestone soluble in acid, and, according to the ingenious method of examining rocks which he has lately brought under our notice, affording, as I cannot omit to say, such valuable and ready information relative to the particulars chiefly required by the geologist, M. Gages further found that the insoluble residue was composed of clay and sand, coloured yellowish by means of oxide of iron and traces of manganese. The specimen marked No. 4 differed from the former only in depositing a mud of a browner colour, owing to the presence of a larger proportion of oxide of iron.

In regard to the origin of these limestones M. Gages offers the opinion that the grains of sand contained in the specimens were probably derived from the removal of transparent quartz existing in rocks previously consolidated, and those grains, held in suspension, being subsequently deposited with the intermixture of clay and oxide of iron, became cemented in the mass of the limestone by the precipitated carbonates of lime and magnesia. I am quite disposed to concur with this view, as, not only in these specimens, but in those of Tullyconnell, grains as well as pebbles of transparent quartz are found to be contained, the rock of the latter locality sometimes occurring in the form of a dolomitic oolite with nuclei of quartzose sand; and the skeletons of rocks (a term used by M. Gages to describe their insoluble residues), taken together with the portions removed by resolution, will often, by their similarity, be found, in my opinion, to afford at least a presumption, forming a substitute as nearly as possible in case of the absence of characteristic fossils,—the same remark applying to an identity of imbedded materials, if supported by an equivalent geological position.

I shall not here discuss the speculation offered by Mr. King, in reference to the existence of an enormous fault running through the hill of Tullyconnell, but from the vertical section before mentioned, I think that Mr. King's suggestion in regard to the superposition of the magnesian limestone over red sandstone is entitled to further consideration.

I may, in conclusion, observe, that the occurrence of the Permian strata of Ireland, at intervals so far apart from each other, would appear

to be a fact of considerable interest, as affording a probability not only of the pre-existence of the formation, but of its subsequent denudation over a wide area, namely, for a distance of thirty-six miles, or, from the eastern shore of Belfast Lough, in the county of Down, to the district south-west of Artrea, in the county of Tyrone; and from its re-appearance, as I have endeavoured to show, at Templereagh, we may have sufficient grounds for ascribing a former superficial extent to these rocks of better than a mile in breadth. It is quite possible that the Permian formation may be found by future investigation to be at the prsent time much more widely extended beneath the superimposed rocks of the north-east of Ireland than has hitherto been supposed; or it may be even ultimately inferred to have once had an existence over the whole of the district extending longitudinally to the eastern Irish coast, and laterally in a straight line northward, at the least from the neighbourhood of Carrickmacross, in the county of Cavan, by Caledon, Dungannon, Maghera, and Dungiven, to the shore north of Newtownlimavady, and east of Lough Foyle, in the county of Londonderry; but, however this may be, it is beside the purpose of my present communication, as I have at all times preferred to be engaged in ascertaining facts, which always possess a fixed and unalterable value, rather than in originating theories which, being insufficiently founded, are, however ingeniously constructed, ever liable to fluctuation and reconsideration.

Remarks were made by Mr. Kelly and Mr. W. H. Baily on the paper.

The President exhibited a specimen of Peat, showing its passage into Coal.

Alphonse Gages, M. R. I. A., read a paper—

ON VIVIANITE.

The important functions which phosphates perform in organic nature give peculiar interest to everything connected with the history of their occurrence as minerals. They are not confined to any one formation, not excepting igneous rocks, but the crystallized phosphates are more usually found in the older formations, while the nodules or masses of phosphate of lime chiefly occur in the more modern formations. Vivianite is, however, a striking exception to what has been just stated, as it has been found in horns of Irish elk, and even in human bones.

Stalagmitic-like concretions and nodular masses of phosphates appear to be immediately derived from organic bodies, and may have been formed by the double decomposition of phosphate of lime held in solution in water by carbonic acid and salts of metallic oxides; or by the reverse action of soluble salts of metallic oxides upon earthy phosphates.

One of the most interesting mineral phosphates is the blue protophosphate of iron, which, when crystallized, is called Vivianite, the earthy varieties being known as blue iron earth, Anglorite, &c. This phosphate is found either crystallized or amorphous in all formations, from the oldest to the most recent, and there is no doubt that it can be formed in a very

brief space of time, as the observations of Schlossberger show that the blue matter sometimes found in the pus of ulcers has the composition of Vivianite, the iron being derived from the disorganized blood corpuscles.

Considerable doubt exists as to the true constitution of Vivianite. Rammelsberg assigned to a specimen analyzed by him the formula :— $4(3FeO, PO_5) + 2(3FeO, PO_5) + 3Fe_2O_3, 2PO_5 + 16HO$, or $6(3FeO, PO_5 + 8HO) + 3Fe_2O_3, 2PO_5 + 8HO$.

The observations of Barreswill upon Abich's salt,—$3(FeO, SO_3)$ $2(Fe_2O_3, 3SO_3) + 4HO$,—which he obtained of an indigo blue colour, appears to lend support to the view that Vivianite contains sesquioxide of iron. On treating the blue sulphate with phosphate of soda, he obtained a blue salt which was not decomposed by water. Rammelsberg assigned to this artificial phosphate the formula—$2(3FeO, PO_5) + 3Fe_2O_3, 2PO_5 + 16HO$.

The ordinary basic phosphate of protoxide of iron obtained by adding a solution of basic phosphate of soda, drop by drop, $3NaO, PO_5$, to a solution of a protoxide salt, and which has the composition $3FeO, PO_5$, is white when first thrown down, but gradually becomes blue on the filter. If the blue colour be owing to oxidation, it must take place very rapidly, and only a very small proportion of sesquioxide must be necessary to produce the blue colour, for the blue colour is found to have penetrated the whole mass on the filter, even before it is wholly washed. This is further shown by dissolving a portion of the blue earthy phosphate in weak hydrochloric acid, and adding sesquicarbonate of ammonia, when a milky white precipitate of apparently phosphate of the protoxide of iron is thrown down. This white precipitate, kept from contact with air, sometimes assumes a bluish tint on exposure to the light. If instead of using weak, cold, hydrochloric acid in the preceding experiments, boiling acid be employed, the solution assumes a reddish tint, and the precipitate thrown down by the sesquicarbonate of ammonia is of a reddish colour; the absorption of oxygen by the precipitate also takes place more rapidly in this case. If we employ caustic ammonia in the first instance instead of the sesqui-carbonate, the precipitate, instead of being milky white, has a reddish tint. The colour of the crystallized Vivianite also deepens, as well as the streak, which, being bluish-white, soon changes to an indigo colour on exposure to the air; and even colourless crystals, as those from the green sand from Delaware, only become blue on exposure. The clay upon which the *blue iron earth* is found is generally whitish, showing that the iron present is protoxide, and it has been observed that the blue bloom is often formed only after exposure to the air. Berzelius considers that the white compound which becomes blue has the composition of $3FeO, PO_5$, or rather a hydrate of it. It is, no doubt, the same compound which is first formed in the elegant process by which Becquerel has succeeded in producing crystallized Vivianite. He forms two cells, separated by a diaphragm of moist clay; in one he puts a solution of sulphate of copper, and in the other, one of phosphate of soda; he then dips a copper rod into the solution of the copper salt, and an iron rod into the solution of the phosphate, and brings the two rods into connexion; after

a time white crystalline nodules are deposited on the iron, which quickly become blue on exposure to the air.

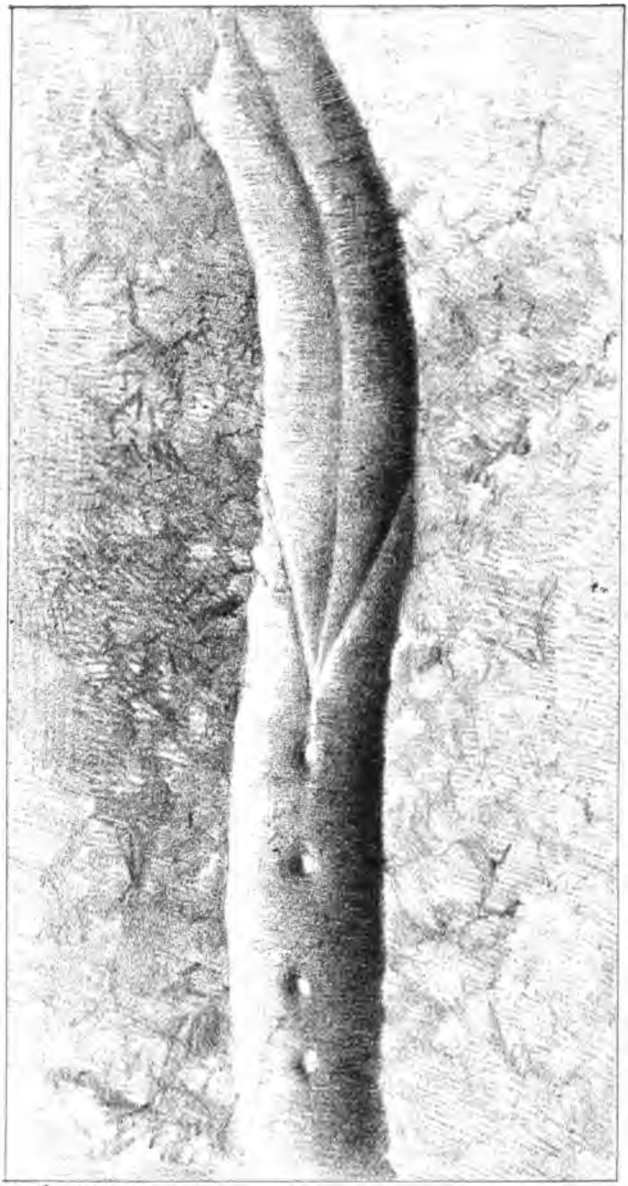
It is not, however, by oxidation alone that Vivianite can be produced; the circumstances under which many specimens are found show that its formation is due, perhaps, oftener to deoxidation than to oxidation; thus in Cornwall it always occurs associated with pyrites, or magnetic iron pyrites. In the first its production may easily be accounted for by supposing the formation of the sulphate of iron and a double decomposition between the sulphate so formed and Apatite; one of the specimens exhibited shows traces of such an origin. Perhaps the Vivianite often found filling the cavities of amygdaloidal trap may have been likewise formed in a similar manner. I have on one occasion observed it coating, like blue paint, zeolitic minerals found in such cavities, clearly proving that its formation was posterior to that mineral.

The most favourable circumstances, however, under which Vivianite appears to be formed by deoxidation is during the decay of the organic matter of the bones. During the process of decay, which in moist earth is necessarily very slow, carbonic acid, marsh gas, hydrogen, and sulphide of hydrogen are evolved. In the presence of such gases, any sesquioxide of iron present would be reduced to the state of protoxide; in this state the carbonic acid evolved by the decomposing bone, or surrounding organic matter, is sufficient to dissolve it, as well as phosphate of lime, which under such circumstances would be rapidly taken up, as the experiments of Moride and Bobiere have fully established. Double decomposition would of course ensue between two such solutions, with a formation of phosphate of protoxide of iron.

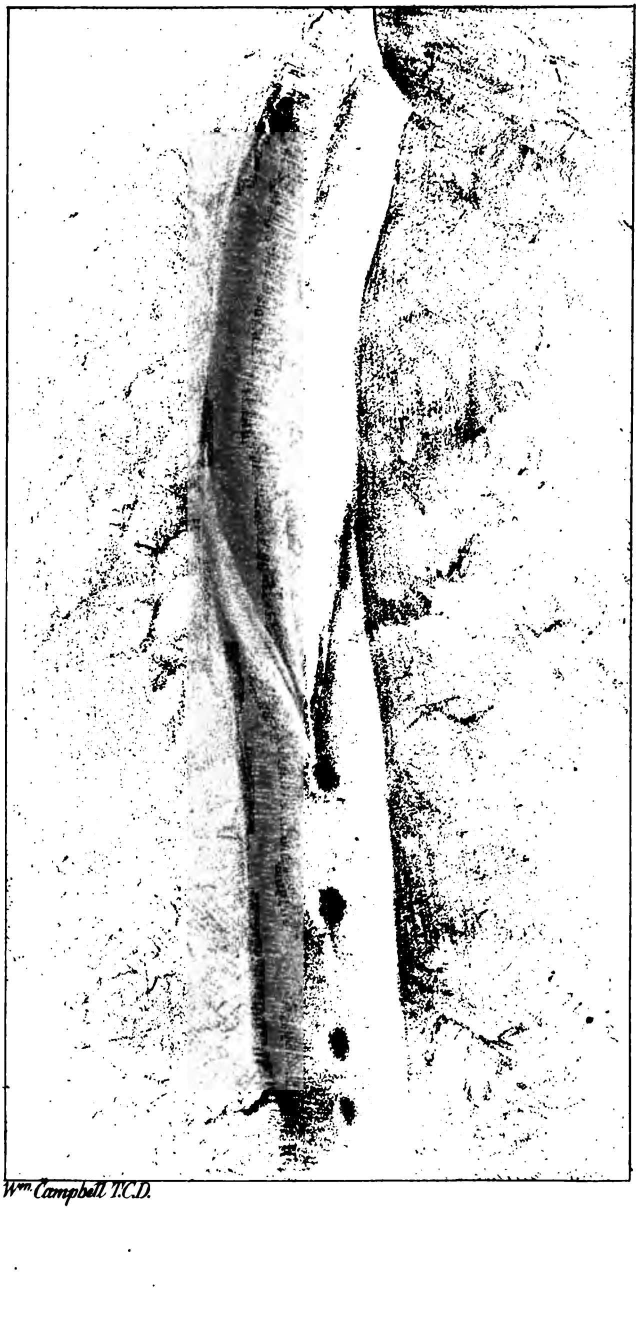
As plants contain a certain amount of phosphoric acid, and as during their decay the same favourable conditions for the reduction of the sesquioxide of iron exist as in the decay of bones, Vivianite may be formed wherever vegetable matter decays in the presence of compounds of iron. For example, the ashes of peat often contain as much as 3 per cent. of phosphate (part being sometimes phosphate of iron), and consequently peaty soils, or turf moors, may be expected to present the conditions essential to the formation of *blue iron earth.* It has accordingly been found in many bogs almost in every county.

The specimen of blue iron earth which I desire at present to consider presents an excellent example of this kind of reducing action. This specimen was obtained from the margin of the bog of Allen; the blue phosphate is disseminated through a mass of clay and sand mixed with peat, or rather what appears to be carbonized peat. The clay itself exhibits traces of combustion, and it appears to be slightly baked here and there; it very probably formed part of a peaty soil burned for the purposes of reclaiming the land. The remains of the plants usually found in peat are observable, such as species of sphagnum, hazel nuts, erica; a stem of the last-named plant, in a perfectly carbonized state, and also some hazel nuts, are covered over with the blue iron earth.

The question naturally suggests itself, whether the action of fire would have had anything to do with the production of the blue phosphate? There can be no doubt that blue phosphatic compounds may be



Wm Campbell T.C.D



Wm. Campbell T.C.D.

formed at a high heat. If phosphate of magnesia or lime containing traces of iron, and intimately mixed with organic matter, be submitted to a strong heat, it frequently acquires a sky-blue colour, evidently due to the formation of a phosphate of iron. This blue colour may often be seen when phosphate of ammonia and magnesia is burned in a filter containing traces of iron; a slight trace of carbonic acid is evolved on moistening the phosphate with an acid, indicating that some of it has been decomposed.

Even if we admit that Vivianite contains sesquioxide of iron, we cannot thereby solve the problem of the blue colour. Beudant suggests that it may be owing to the hydration of the phosphates, instancing the example of the white anhydrous sulphate of copper becoming blue on taking up its water of crystallization. This might account very well for the production of colour in compounds which pass from the anhydrous to the hydrated condition, but cannot apply to the phosphate, inasmuch as the white phosphate precipitated from protosalts of iron is hydrated while in the white condition; and it has never been shown that there is any change in the quantity of water in passing from the blue modification. Then there is the formation of a blue phosphate in the crucible, under conditions which precludes the possibility of water of hydration. The change may be allotropic, or, perhaps, like the change of colours which light produces in some kinds of glass, which gradually assume a decided pinkish tint, although at first free from colour. This tint is due to manganese; but how are we to account for the gradual development of the colour?

Major Leach, R. E., exhibited a specimen of Clay from Hong Kong, the smell of which was said to be injurious to health.

Donations were announced, and thanks voted to the donors. The Meeting then adjourned.

GENERAL MEETING, WEDNESDAY, JUNE 8, 1859.

Rev. Professor Haughton, F. T. C. D., F. R. S., President, in the Chair.

The Minutes of last Meeting having been read, were approved of, and signed by the Chairman.

Dr. E. Perceval Wright, F. L. S., read the following—

DESCRIPTION OF A GEOLOGICAL SECTION MADE IN THE VALE OF OVOCA.

BY FREDERICK W. EGAN, C. E., AND HENRY GEOGHEGAN, C. E.

The section extends from Wooden Bridge, in the Vale of Ovoca, to Greenan Bridge, following the course of the river. Its direction from Newbridge to Greenan Bridge is nearly at right angles to the strike of the slate, which does not vary much from east and west (magnetic), though between Wooden Bridge and Newbridge it turns towards south-east, and near Greenan Bridge towards north-east.

The dykes of elvan and greenstone crossed preserve a direction nearly parallel to the strike of the slate, which fact aided us in many instances in determining their presence. Their direction is, generally speaking, plainly seen by the lines of large blocks appearing in the fields; in some cases, however, we experienced considerable difficulty in determining it.

At a short distance from Wooden Bridge, a sudden change in the dip of the slate is well exhibited on the road-side, where it becomes vertical from 35° south, with some contortions. The strike is also changed from E. 10° N. to E. 10° S. On the left* bank of the river, at the turn, we observed large masses of greenstone, indicating the presence of a dyke, which probably caused the change of dip and contortions above mentioned. The apparent direction of the dyke being the same as the strike of the beds, confirms our opinion that there *is* a greenstone dyke in the place marked. The dip on the other side of the dyke is north, in which direction it continues for some distance towards Newbridge. The dips in the slate, which is continuous between this dyke and Newbridge, are as marked on the map and section; the strike of the beds turning gradually from E., 30° S. towards E. and W., while the dip changes from north to south, the slate being vertical and contorted in places.

The arrangement of the beds in this space seems to indicate a synclinal fold, though not undisturbed, to investigate which point we walked over the country, taking dips along a line at right angles to the general direction of our lines from Wooden Bridge to Newbridge, the exact direction of which is marked on the plan. We have drawn a rough section on this line, extending it as far as Rockview.

By comparing the rough section with the part of the main section between the beginning and Newbridge, we judge that the indications of a synclinal in the latter are strengthened. The strike turns more rapidly than on the main line, from south of east to north-east, the dips corresponding with those on the main line, though changing more abruptly. These facts are chiefly due, no doubt, to the direction of the section which is more nearly at right angles to the strike of the slate than the main section.

In some places on the road from Wooden Bridge to Newbridge, the slate is covered, to a depth of ten or fifteen feet, with clay, including small fragments of slate mixed evenly with it, and distributed horizontally, also a few pebbles and small boulders. There is also at Newbridge a gravel pit, at the side of the road, which exposes, to a depth of twenty feet, a deposit of gravel and sand, with bands of plastic yellow clay, the gravel being chiefly quartz and slate. We could find no shells in this deposit.

On the west flank of the greenstone outburst which forms the hills behind Rockview and Snugborough, we found the slate dipping generally from the greenstone, but in the line of section vertical.

* The banks are called right and left with regard to the direction of our course.

A deposit of gravel and clay occurs in two valleys on the line of section near Rockview. It is exposed in pits to a depth of twenty or thirty feet, and is very similar in appearance to that mentioned above at Newbridge. We were again unsuccessful in our search for indications of its age.

Our line of section (main) crossing the river close to Newbridge, cuts a greenstone dyke very distinctly seen in the right bank, and apparently causing a sudden change in the direction of the river, which runs straight against its side, and turns off almost at right angles. The slate on the other side of this dyke is very much hardened, striking fire with the hammer. The dip is 80° south, corresponding with dips observed on the hill to the east of the point where the dyke cuts the river, the strike being in each case E. and W.

A large outburst of fine granite, about ⅓rd mile wide, occurs a little further, extending nearly to the point where our line crosses the river. At this point the river runs between two high cliffs, chiefly composed of very hard, altered slate. The cliff on the right hand we have marked in the section as altered by the granite; the other is not entirely composed of slate, as there are large masses of greenstone in front.

The section next crosses the iron pyrites lodes of the Ballymurtagh mines, which bear E. 8° N. as we observed from the south lode which has been opened on the back. The underlay of these lodes is 30° south, and they occur in slate dipping from 55° to 60° south.

The slate in many parts in the vicinity of the mines becomes of colours quite different from the usual. In some places it is of a jaspery red; in others nearly white; in others a light yellow.

From the mines to Greenan Bridge the country is literally cut up with elvan dykes. These do not appear to affect the dip of the strata materially, except in two cases where they occur close together, and where the dip is reversed or contorted; neither do they appear to alter the internal structure of the slate.

About half a mile from the mines a lode of sulphur ore has been opened lately by an adit; with the assistance of the miners' candles we took the bearing of the adit, and found it east and west; its underlay, as taken from the "floor," we found to be 25° South.

A large elvan dyke, or a collection of several small ones, occurs at the Meeting of the Waters, in determining the position of which we found considerable difficulty. A greenstone dyke occurs about 300 yards from the Bridge at the Meeting of the Waters, which is opened by a quarry on the side of the road. The slate in contact with the greenstone is altered in colour and hardness, as we found in the case of the greenstones at Newbridge and Rockview. It appears that this is the tail of a dyke as we could find no trace of it on the banks of the river or on the opposite side.

A little further a lode of sulphur ore occurs between two elvan dykes which apparently does not cross our section. The slate is thrown up vertically between the two elvan dykes.

The miners showed us in the vicinity an old shaft, now filled with

water, with heaps of what they said had been extracted as *ore* lying about the mouth. This appears to us to be nothing but the gangue in which the common sulphur ore is found, and contains no more ore than a few very minute spangles of pyrites. When treated with nitric acid, the orange fumes are scarcely perceptible, and the solution of but a light green, and in the outer flame of the blowpipe no sulphur fumes can be detected. Specimens 15 are from the vicinity of the lode above mentioned, and were described to us by the miners as "touching on lead." The brown substance dissolves, on application of heat, entirely in muriatic acid with effervescence, the solution being yellow, and becoming yellowish-red on the addition of nitric acid. It colours a bead of borax green. From these facts it appears to be a carbonate of iron, containing probably a considerable quantity of carbonate of lime, as we judge from the copious effervescence which takes place before the application of heat.

There are two outbursts of granite to the south of Ballinaclash, which are rendered conspicuous on approach by a large hill formed entirely of granite on the right bank. This hill is part of the larger outburst; its identity with that on the left side of the river being shown by its direction as well as the masses of granite exposed on the banks of the stream. The slate is altered by those outbursts for some distance. We have specimens from different parts of the granite.

The rest of the section is through slate intersected frequently by elvan dykes running E. and W. The dip of the slate gradually becomes more vertical till at Greenan it is 80° S.

The slate at this place on both sides of the river abounds in cubes of iron pyrites and their casts filled with oxide of iron, of which we have several specimens.

The difference in the mode of dissemination of the iron pyrites through the slate is curious. While at Greenan and the vicinity it appears as scattered crystals; further south it is collected in bands of close-grained ore. The slate in this part of the section becomes somewhat bluer than usual, as may be seen from specimen 23.

LIST OF SPECIMENS.*

1. Average specimens of Lower Silurian slate.
2. Altered slate from side of greenstone, near Rockview.
3. Weathered greenstone, from same place.
4. Greenstone with quartz vein.
5. Greenstone from Rockview.
6. Pebbles from gravel pits at Rockview.
7. Vesicular greenstone from junction of greenstone and slate.
8. Altered slate from edge of greenstone dyke at Newbridge.
9. Granite from outburst near Newbridge, right bank.
10. Specimens of altered slate from the mines.
11. Specimens of sulphur ore from the mines.
12. Altered slate from side of elvan dyke (2nd from mines).
13. Altered slate from side of greenstone dyke, near Meeting of Waters.

14. Gangue from old workings.
15. Mineral said by miners to indicate lead.
16. Slate altered by granite from near Ballinaclash.
17. Slate and granite at junction from same place.
18. Granite, with sudden change of colour in mica.
19. Granite of outburst at point where crossed by section.
20. Slate altered by granite outburst.
21. Slate with crystals of iron pyrites and casts.
22. Slate with small contortions.
23. Slate at Greenan Bridge.
24. Slate with collection of iron pyrites from right bank near Greenan.

Robert Caldwell, Esq., V.P., took the Chair, while the President read a paper "On the Crystallographic Relations of the Mica of the Three Rock Mountain." Also a paper—

ON A NEW CARBONIFEROUS ECHINODERM, FROM THE COUNTY OF LIMERICK.

THE fossil under examination was given to me by the Rev. Hamilton Jones, of Adare, county of Limerick, who thus describes the geological structure of the locality in which it was found:—

"It was found in the parish of Adare, townland of Barnalick, seven miles from Limerick, and five from Rathkeale. The locality presents some variety in surface rocks; though, as far as I can see, the permanent strata are uniformly gray limestone; the surface rocks are mainly gray limestone also. But there are numerous blocks of a dark blackish-gray limestone, abounding in Fenestellæ and Spirifers. In appearance and colour it resembles the Calp found some miles distant to the north, but it is soft and rotten when tried with the hammer. In a piece of this rock the specimen you have was found."

It is perfectly new, and, so far as I know, no Echinoderm at all resembling it has yet been found in the carboniferous rocks. I have given four views of it, *ad naturam*, in Plate XXIX.

PLATE XXIX.

Fig. *a*.—View of fossil from above, showing the five united ambulacra, not provided with a furrow in the centre.

Fig. *b*.—End view of inverted fossil, showing a portion of the shell, not removed, with a very doubtful appearance of an aperture (anal?)

Fig. *c*.—Side view of inverted fossil—showing the want of symmetry.

Fig. *d*.—View of fossil from below—showing also the apparent want of symmetry.

The specimen is a natural cast of the interior, and the shell is only preserved on one side, as shown in Fig. *b*;—the internal impression of the ambulacra is beautifully shown, as in Fig. *a*.

I believe it to be allied to the Pentremitidæ, but free, and that it owes its want of symmetry to distortion by pressure occasioned by the surrounding mud when soft. This want of symmetry gives it a spatan-

giform appearance, which, taken in conjunction with the obscure trace of an anal aperture, shown in Fig. *b*, would almost suggest an affinity with the Echinida instead of the Crinoida, with which latter, however, it must be classed.

It is much to be desired that additional specimens should be found, as the present cast is insufficient to determine completely its relations and affinities. I would propose for this fossil the provisional name of *Pentephyllum Adarense.*

The generic name records its most striking and beautiful feature (πεντε, five; φυλλον, a leaf), as exhibited by the regular flower-like impression of the ambulacral plates. The specific name I have given at the request of Mr. Jones, partly in commemoration of the locality (Adare, county of Limerick) where this remarkable fossil was found, and partly in honour of his pupil, Lord Adare, who, like his father, is known to take an interest in the natural sciences.

Until the plates, which form the covering of our fossil, shall turn up, a more scientific description would be misplaced.

Dr. E. Perceval Wright read a paper "On a recent Submarine Formation in the Irish Channel."

Appendix to Professor Haughton's Paper, p. 87, *ante*.

Description of Plates XXII., XXIII., XXIV., XXV.

These Plates are intended to illustrate the fossil tracks exhibited to the Society by the President on the 12th May, 1858, which were discovered by him, in conjunction with his brother, Mr. Frederick Haughton, at Lugacurren, in the Queen's County, in the beds lying below the coal-beds of the collieries of that neighbourhood. They appear to occupy a geological position similar to that of the fossil tracks found in the coal-measures of Northumberland.

Plate XXII., *ad naturam.*—This Plate represents the most characteristic of the Lugacurren fossil tracks: it is of the natural size, and shows the passage from a simple track, with transverse lines through another track, provided with a deep median groove, more or less continuous, into a third fossil track, characterized by regular indented punctures, occurring at equal intervals. Both the grooves and punctures occur as indentations on the upper surface of the flagstones, and as elevations on the casts of those formed on the under surfaces.

These tracks, in their smooth and grooved portions, resemble those from Northumberland, figured by Mr. Hancock in the "Annals and Magazine of Natural History," December, 1858, Plates XVIII. and XIX. But the third variety of track, made by the same animal, does not appear to have been observed in the north of England.

PLATE XXIII.—Figs. *a*, *b*, *c*, *ad naturam*

Fig. *a*.—Vermiform track, not very abundant at Lugacurren; perfectly round in section.

Fig. *b*.—A common form. This presents a striking resemblance to some tracks of recent crustaceans figured by Mr. Hancock.—"Annals, Natural History," vol. ii., Plate XV.

Fig. *c*.—Track of the characteristic fossil of Lugacurren.

PLATES XXIV., XXV., *ad naturam*, show the form of the termination of the body of the animal that left the punctured track. This may possibly have been a Trilobite, and the regular punctures may have been produced by the animal shoving itself along occasionally, by means of the sharp spud at the extremity of its tail.

Appendix to the Rev. Eugene O'Meara's Paper, p. 105, *ante*.

The following is the list referred to by the Rev. Eugene O'Meara in his paper "On the occurrence of recent Diatomaceæ in the Lower Tertiaries of Hampshire."

Amphora ovalis.
Achnanthidium microcephalum
Cyclotella operculata.
,, rotula.
Cocconeis pediculus.
Cocconema cistula.
,, parvum.
Collotonema neglectum.
Cymatopleura solea.
Diatoma elongatum.
,, grande.
Diatoma vulgare.
Denticula tenuis.
Epithemia alpestris.
,, sorex.
,, zebra.
Fragillaria capucina.
Gonphonema acuminatum.
,, constrictum.
,, dichotomum.
,, intricatum.
Gonphonema olivaceum.
Himantidium arcus.
,, gracile.
,, soleirolii.
,, undulatum.
Melosira varians.
Meridion constrictum.
Navicula amphisbæna.
,, decephala.
,, rhyncocephala.
Nitzchia amphioxys.
Orthosira orichalchea.
Odontidium mutabile.
Pinnularia mesolepta.
,, radiosa.
,, viridis.
Pleurosigma attenuatum.
,, Spenserii.
Surirella ovata.
Synedra radians.
Tabellaria fenestrata.

Donations were announced, and thanks voted to the donors. The Meeting then adjourned.

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WEDNESDAY EVENING, NOVEMBER 9, 1859.

REV. SAMUEL HAUGHTON, President, in the Chair.

THE Minutes of last Meeting were read and confirmed; donations announced, and thanks voted.

The following gentlemen were elected Members of the Society:—1. Francis Battersby, M. D., 16, North Cumberland-street; 2. Murdock Green, Esq., 52, Lower Sackville-street;—and the following as Associate Members:—1. Robert Robertson; 2. John Gibbon; 3. H. Townsend; 4. W. Crawford; 5. B. T. Patterson; 6. R. G. Symes; 7. R. P. Tudor; 8. Robert Denny; 9. R. A. Duke; 10. C. W. Bateman; 11. J. M'Grorty; 12. Thomas Cook; 13. Samuel Hunt; 14. W. C. Dopping.

MR. GEOGHEGAN read the following paper:—

DESCRIPTION OF A SECTION THROUGH THE SILURIAN AND CARBONIFEROUS FORMATIONS OF HOOK HEAD, COUNTY OF WEXFORD. BY HENRY T. GEOGHEGAN AND BENJAMIN T. PATTERSON.

THE section commences at the junction of the Silurian slates with the detached portion of old red conglomerate in Dollar Bay, on the west coast of Hook Head, and at a distance of about six miles from the lighthouse point. Its direction conforms approximately with the outline of the western coast of the peninsula.

The slates near the junction are thickly covered with alluvium, and, where they do appear, are so broken up and contorted that we could not make a satisfactory observation nearer to the junction than about 200 yards.

At the southern side of Dollar Bay the old red conglomerate immediately succeeds the slates, lying quite unconformably on them. It forms a cliff of from fifty to seventy feet high along the shore, and is of very massive structure. We searched diligently, but in vain, for any indication of bedding, and did not succeed in making an observation until we had rounded Brownhill Point.

The shore along the remainder of this portion of the conglomerate is in general very precipitous, and at some points is indented by small bays, the cliffs round which rise to a height of about 150 feet.

Notwithstanding the unfavourable nature of the coast, we succeeded in making several observations; and, in making them, were generally guided by the undenuded portions of thin beds of fine red sandstone, which occur frequently in the conglomerate.

The dip we found to be generally out to sea, i. e. a little south of west; it varies from 10° to 17°.

This conglomerate is of a very coarse description, and there does not appear to be any sorting or arrangement of the pebbles, which are mostly of quartz, with a smaller proportion of slate, some pebbles of which we observed to be as large as 1′ 0″ to 1′ 6″ diameter, which re-

tain their stratified and cleavable structure in so great a degree that, where exposed, some of them were breaking up into "pencil." This would show (in accordance with Professor Haughton's theory of the development of cleavage) that the slates had been subjected to the pressure which produced the magnificent contortions to be seen on this coast long before the formation of the conglomerate.

Near Brownhill Point we found a pebble (Specimen No. 1) of volcanic ash in the conglomerate; its vesicular structure proves it to have been thrown into the air in a molten state from the crater of some volcano which harmlessly poured forth its lava and scattered its ashes on the barren Silurian land around. Here we have proof that even at this early period in the history of our globe its crust was convulsed by volcanic action.

The deposit of alluvium and vegetable soil over the conglomerate appears to be very small, and the vegetation is scanty. Near the southern termination of this detached portion of conglomerate a fault occurs. Its bearing is E. 25° S.; it follows the direction of the joints; many cut pebbles, and some of them of large size, appearing in its sides. It occurs at a distance of about thirty or forty yards from the southern end of the conglomerate.

The cliffs of slate beyond the conglomerate suddenly recede about forty yards, and from observing this form of coast, and the fact that the shore immediately to the south of the fault was heaped with large broken masses of the conglomerate, we were led to conclude that the fault had been produced by the wearing away, by the sea, of the slates which lie under the conglomerate, and the consequent breaking away along the line of fault of the part thus undermined. This opinion seems to be borne out by the want of evidence of the production of the fault farther inland than where the slate cliffs abut against the conglomerate.

The slates occur again between this and the main body of the conglomerate for a distance of about three-quarters of a mile along the coast. They are in some places wonderfully contorted; in many cases the beds have been doubled so as to form an angle of 30° or less, fracture sometimes occurring.

Wherever we found the dip and strike at all persistent, we made observations. Dip varies from 30° to 75°.

At the southern side of Templetown Bay we again find the conglomerate, which at this point forms cliffs of considerable height. Its structure, like that of the portion before noticed, is very massive.

There being very few traces of bedding, and no exposed surface upon which we could make a correct observation, we had to be content with an approximate one.

The junction is very clearly exposed in the cliff, and inclines towards the south at an angle of about 34°.

Several extensive fissures and slight faults occur in this portion of the conglomerate.

The first of these fissures occurs at a distance of about 150 yards

from the junction. Its bearing is E. 30° S. We could not detect any evidence of subsidence on either side. The same may be said of another large fissure, about 100 yards further south.

At one-third of a mile from the junction a small double fault occurs; the fissure has been weathered out towards the shore so as to be V-shaped on plan, and the displacement of one of the beds of fine sandstone, which often occur in the conglomerate, shows very evidently a subsidence to the south.

The beds along this portion of the cliffs are very thick, and a great quantity of large blocks lies along the shore.

At a point a little to the north of Harrylock Bay there is a very remarkable cave, called the Scout's Hiding-place. The entrance is 40 feet wide by 7 feet high, both the floor and roof gradually ascend towards the interior; the width of the widest part is 60 feet, and the depth from the mouth 80 feet. Several great blocks lie on the floor, which appear to have fallen from the roof. The whole appearance of the cave is as if a huge block of one of the thick beds of conglomerate, in which it occurs, had been mortised out from between the under and overlying beds.

About 100 yards to the south of this cave we found another fissure, which, from the disagreement between the strata forming its walls, we concluded to be a fault; and, from the dip of the fissure being southerly, it is probable that the subsidence has been on the south side, as in the former fault. The opening towards the shore is V-shaped to a depth of about 20 feet. The strata forming the north wall are very thick beds (15 feet to 20 feet) of conglomerate, without any of the fine red sandstone of which the base of the south wall, to a height of 25 feet, is composed. This fine sandstone is succeeded by a three-feet bed of conglomerate; then there is another fine bed, about 15 feet thick, the whole being capped by a nine-feet bed of conglomerate. Thus it is seen that there is no correspondence between the strata on either side. It would be difficult to determine the amount of subsidence, but we believe it must have been upwards of 50 feet.

The strike of the beds between Templetown and Harrylock Bays is slightly variable. The dip is generally southerly, and varies from 10° to 15°.

Under the village of Harrylock, the fine red sandstone beds are more frequent, and the shore is formed of large angular blocks of conglomerate, the beds of which appear to have broken up along joints, as the sandstone, which is much softer, was weathered away from under them. No blocks of the fine sandstone are to be seen.

The conglomerate, or, as the workmen call it, "Millstone Grit," is held in some repute as a material for making millstones, stones from this neighbourhood being used by many of the mill-owners of Wexford and Waterford.

To the south of Harrylock the conglomerate becomes less plentiful, its place being supplied by grit and fine red and yellow sandstones, some of which are very micaceous.

At the south point of Lumsdin's Bay, the lowest portion of the alluvium contains many pebbles, both large and small, of the conglomerate and fine red sandstone; and its colour shows that about six feet in depth of it was derived almost entirely from conglomerate and red sandstone beds. The upper portion is of a yellow colour.

On nearing Loftus Hall, we found the beds of compact limestone again alternating with the shales, and gradually increasing in frequency and thickness until we reached Loftus Hall point, where the strata (which are nearly horizontal, and are exposed in a vertical section about 20 feet high) consist of beds of limestone, some of which are two feet and a half thick, with a few thin beds of shale, which we saw here for the last time.

From Lumsdin's Bay to Loftus Hall point the strike varies; the variation, however, does not exceed about 30°. The dip is generally southward, and decreases from about 30° at the former to 5° at the latter point, where there is a slight disturbance at the beds.

The limestone to south of Loftus Hall is of a hard, flaggy description, and the inclination of the beds small, 5° to 10°. At about 300 yards north of Duffin's Well the strata are a good deal disturbed and bent.

Immediately to the south of the well we observed an extensive crack (bearing N. 35° E.) running nearly in the strike, which here changes rather abruptly from E. and W. to N. 30° E. It is filled with calc spar, which in some places encloses large pebbles of limestone. Its breadth varies from 1 to 3 feet.

From the separation of these blocks of limestone (which are somewhat rounded) by the carbonate of lime, we consider that the vein could not have been formed, by the infiltration of carbonate of lime, round a mass of shingle collected in the crack, but that occasional partially rounded pebbles were thrown in during the formation of the calc spar.

The alluvium immediately north of Rockwell contains pebbles of slate, conglomerate, and limestone; the conglomerate becomes scarce below Loftus Hall. We noticed a large boulder here of green hornblende and feldspar.

At about 80 yards north of Rockwell, there is a very large fissure (bearing E. 10° N.) running inland, but we could find no evidence of misplacement of the beds.

Again, south of Rockwell, there is a change in the strike from N. E. to E. 5° N., accompanied by a long crack nearly in the former strike. From the section it may be seen that this part of the limestone has been subjected to disturbing forces, which probably produced the fissures above mentioned, which may be faults, though we have not marked them as such in the section from want of evidence of any displacement of the beds.

From Rockwell southwards the limestone assumes a different aspect, being more highly cleaved, and weathering very black; the structure is highly crystalline, and there is scarcely any effervescence with muriatic acid unless it be scratched. These characters show it to

be dolomitic. There are, however, occasional beds of limestone of the ordinary appearance.

The limestone prevails before we come to the point north of Doornoge Bay; but at the point there are thick beds of black dolomite, which has a very crystalline structure. (See specimens Nos. 13–15.) The beds are intersected by very large fissures, the general direction of which corresponds with the strike. The sea washes with great violence into these fissures, and has hollowed one of them out into a magnificent cave, which retreats so far inland that nothing can be seen of its end from the outside, nor could we distinguish any sound to indicate that the waves, which rushed into it in rapid succession, met with any obstacle in their course. The dolomite is carved out into all sorts of fantastic shapes, forming sometimes natural bridges over the chasms, in which the confined waves lash themselves into masses of white foam.

Over this cave we found numerous large boulders of grit of very peculiar appearance (see specimens Nos. 11 and 12); it is composed of gray quartz and red felspar, with a small quantity of white mica. Some of the crystals of quartz and felspar are large, and in some of the boulders the mass of the stone is of deep purple colour. The grit beds, of which these boulders formed portions, were perhaps formed directly from granite. The angular forms of the felspar crystals may indicate metamorphic action subsequent to deposition.

The dolomite above noted is brought to the surface by an *anti*-clinal axis, and should come to the surface again on the other side of the corresponding *syn*-clinal to the north, unless we suppose that such an extensive and well-marked series of beds changes its character in the short distance of half a mile.

From several circumstances, however, we are led to believe that there is a large fault on the north side of the synclinal, which has thrown down the beds on the south to a depth of 400 or 500 feet, thus accounting for the absence of dolomite on the north side of the synclinal.

The facts corroborating this opinion are as follows: There is a considerable disturbance (previously noted) of the beds of limestone, 300 yards north of Duffin's Well, and, on the east coast the strata, at the south point of Bullock-park Bay (consisting of dolomite) are divided by two immense fissures, open for some distance inland, and bearing N. 25° W., which is nearly the direction of a line drawn from this point to the contortions on the other side. They also correspond in direction to the strike of the beds to *their* south, which corresponds, within 20°, to that of the beds immediately to the south of the contortions on the west coast, so that it would appear that the same axis of force produced the disturbances and strike of the beds on each side of the peninsula.

The fault would appear to have thrown down the beds much deeper on the west coast than on the east, as we find dolomite on each side of the fissures in Bullock-park Bay; and it could not, therefore, have caused a downthrow equal to the thickness of the dolomite beds at that place, while on the west it must be more, though not much more, than the same thickness. The dolomite has also, as we might expect, been

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more *elevated* on the west coast at the anticlinal above mentioned, being exposed by it for a considerable thickness, while on the east it does not appear further south than Bullock-park Bay.

It is possible that the extensive fissures in the neighbourhood of Rockwell may have been produced by faults, and, if such is the case, it would not be necessary to suppose so great a downthrow to have occurred at the principal fault described above.

In the middle of Doornoge Bay there is another large fissure, accompanied by a sudden and violent change of the dip and strike on its south side.

The strike of the beds wheels round again through more than 90° between this and the head, where it has more than resumed its general direction. The dip, which from Rockwell to Doornoge Bay varies from 10° to 30°, is reduced on the south of the fissure to 5°; but it again varies between this and the head, where it is about 12°.

There is another fissure just outside the lighthouse wall, bearing N. 35° W. It passes quite across the point, and, although the sides are not separated at the surface throughout the whole length, they are so at the ends, and about the middle there is a hole, at the bottom of which the sea is seen, having made its way along the fissure beneath.

We had not time to do much more on the east coast than to walk along it, but, in doing so, observed an exactly corresponding series of beds to those which we had more closely examined on the west coast.

The whole of the limestone beds abound in beautiful fossils; at some places the beds appear to be almost entirely formed of encrinite stems and arms. It was a cause of regret to us that, our stay being limited, we could not spare the time requisite to obtain a collection of good specimens.

LIST OF SPECIMENS FROM HOOK HEAD.

No. 1. Specimen of volcanic ash from old red conglomerate at Broomhill Point.

No. 2. Carbonized remains of "linear" plants from micaceous sandstone beds, south of Harrylock.

No. 3. Same as last, from corresponding beds on E. side of peninsula.

No. 4. Specimen of gray copper-ore from bed of grit S. of Harrylock.

No. 5. Specimen of last-named bed, saturated with carbonate of copper.

No. 6. Encrinites, &c., from upper part of calcareous sandstone, N. of Lumsdin's Bay.

No. 7. Specimen of lower and unfossiliferous part of same beds.

No. 8. Fucoid remains from large sandstone boulders lying close beside the beds from which the last specimens were obtained.

No. 9. *Michelinia favosa*, from limestone close to Rockwell.

No. 10. *Actinocrinus polydactylus* (?), showing stem, pelvis, and annus, from limestone between Rockwell, and dolomite.

No. 11. Specimens of grit boulders, found on dolomite.

No. 12. Same as last, with purple cement of peroxide of iron (?).

No. 13. Specimen of dolomite from point north of Doornoge Bay.

No. 14. Same, from a little further north, showing black weathering.

No. 15. Same, from corresponding beds at Bullock-park Bay, on E. coast.

TABLE *of Observations made along West Coast of Hook Head, from Dollar Bay to the Point.*

No.	Strike.	Dip.	Formation.	No.	Strike.	Dip.	Formation.
1	E. 20 N.	45° N.	Red Sandst.	32	N. 30° W.	23° W.	Red Sandst.
2	N. 10° E.	17 W.	"	33	N. W.	10 S. W.	"
3	N. 10 W.	16 W.	"	34	W. 35 N.	22 S.	Yell. Sandst.
4	N. & S.	10 W.	"	35	W. 25 N.	25 S.	"
5	N. 10 W.	15 W.	"	36	W. 10 N.	20 S.	"
6	N. 35 E.	10 W.	"	37	W. 12 N.	30 S.	Limst. Shale.
7	E. 5 S.	Contorted.	Slate.	38	W. 42 N.	15 S.	"
8	E. & W.	70 S.	"	39	N. 30 W.	28 W.	"
9	E. 10 N.	55 N.	"	40	W. 35 N.	20 S.	"
10	E. 15 N.	55 N.	"	41	W. 25 N.	10 S.	Limestone.
11	E. 30 S.	30 N.	"	42	W. 35 N.	8 S.	"
12	N. 20 E.	34 W.	"	43	W. 25 N.	5-10 S.	"
13	N. 32 W.	45 W.	"	44	W. 4 N.	10 S.	"
14	W. 36 N.	42 S.	"	45	". . . .	5 S.	"
15	E. 8 S.	75 S.	"	46	E. 14 N.	10 S.	"
16	E. 30 N.	60 S.	"	47	W. 35 N.	15 S.	"
17	E. 40 N.	50 S.	"	48	E. & W.	25 S.	"
18	W. 23 N.	60 S.	"	49	N. 30 E.	25 E.	"
19	E. 5 N.	45 S.	"	50	N. E.	20 S. E.	"
20	E. 30 N.	60 S.	"	51	N. E.	20 S. E.	Dolomite.
21	E. & W.	65 S.	"	52	E 5 N.	10 S.	"
22	E. 40 N.	40 N.	"	53	N. 25 E.	18 E.	"
23	W. 22 N.	50 S.	"	54	E. 20 N.	15 S.	"
24	N. W.	18 S.W.	Red Sandst.	55	E. 15 N.	20 S.	"
25	N. 20 W.	15 S.	"	56	E. 5 N.	32 S.	Limestone.
26	N. 35 E.	12 W.	"	57	N. 18 E.	5 E.	"
27	E. 10 N.	10 S.	"	58	E. 40 N.	5 S.	"
28	E. 25 N.	11 N.	"	59	E. 16 N.	15 S.	"
29	E. 16 N.	5 S.	"	60	N. W.	10 S. E.	"
30	N. 10 W.	15 W.	"	61	E. 40 S.	12 S	"
31	N. 8 W.	33 W.	"				

ROBERT CALLWELL, V. P., took the Chair while the President read a paper "On the Direction of the Joints in the Limestone of the County of Fermanagh."

DR. J. F. SIDNEY exhibited some specimens of lignite, found near Armagh, under the circumstances detailed in the following letter from Mr. N. M'N. Edmondson:—

"ARMAGH, *Nov.* 8, 1859.

"DEAR SIR,—The cutting is through the side of a clay hill, the depth of which is forty-five feet; the wood was found at the bottom.

"Several specimens were dug up within a space of three or four square yards. The rock is limestone, and was reached in digging for the foundation of the bridge over the River Callan, about 250 yards west of the cutting, and some 40 feet below the level of the railway.

The hill is north-west of the observatory, distant about 900 yards. Another specimen was found in a cutting on the Newry line, at a depth of about 55 feet. The place is north-east of the observatory, and distant about 2000 yards. The rock is limestone, and quarried on the foot of the hill.

"My very limited knowledge of geology prevents me from giving the proper details; there is one feature, however, in the clay hills about Armagh where the limestone is underneath, which, perhaps, I should mention.

"The upper part, to a depth of about 25 feet, is reddish clay, and the boulders mostly limestone, tolerably well water-worn; but from that down, so far as I have seen them opened, the clay is dark, and the boulders nearly all consist of trap and hard bluish slate, very much water-worn.

"Occasionally a bit of limestone is found, but so much water-worn as to be almost completely polished.

"Yours truly,

"N. M'N. Edmondson.

"*Dr. Sidney.*"

GENERAL MEETING, JANUARY 11, 1860.

Lord Talbot de Malahide in the Chair.

The Minutes of last General Meeting having been read, were approved of, and signed by the Chairman.

The following gentlemen were elected Members of the Society:—1. J. Scott Moore, The Manor, Kilbride, Co. Dublin; Wm. F. Walker, 2, Trinity College; 3. Dr. Stokes, Merrion-square; 4. Dr. John Barker, 48, Waterloo-road;—the following as Corresponding Members:—1. John Gordon, C. E., India; H. B. Hargrave, India; John R. Hime, Pernambuco;—and the following as Associate Members for the year 1859-60:—W. B. Brownrigg; H. Geoghegan.

The Rev. Samuel Haughton, F. R. S., President, read the following—

GEOLOGICAL ACCOUNT OF THE ARCTIC ARCHIPELAGO, DRAWN UP FROM THE SPECIMENS COLLECTED BY CAPTAIN F. L. M'CLINTOCK, R. N., FROM 1849 TO 1859.

[The following paper, illustrated by a Geological Map of the Arctic Archipelago, was published as an Appendix to Captain M'Clintock's "Journal of the Voyage of the Fox," December, 1859.—S. H.]

The Map which was published with this geological description is coloured from the specimens brought home by Captain F. L. M'Clintock, R. N., from the Arctic Expeditions in which he served from 1848 to 1859. These specimens are all deposited in the Museum of the Royal Dublin Society, and form a more extensive and better collection of Arctic rocks and fossils than is to be found in any other museum in Europe.

It will be most convenient to describe the Geology of the Arctic Islands by the formations which are to be found there, which are the following:—

1. The Granitic and Granitoid rocks.
2. The Upper Silurian rocks.
3. The Carboniferous rocks.
4. The Lias rocks.
5. The Superficial Deposits.

I shall describe these successive formations briefly, and add a few remarks of a theoretical character, to indicate the important inferences which may be drawn from the facts respecting them, made known to us by M'Clintock's discoveries.

I. The Granitic and Granitoid Rocks.

These rocks form a considerable part of North Greenland, on the east side of Baffin's Bay, and constitute the rock of the country at the east side of the Island of North Devon, which forms a portion of the coast line of the west of Baffin's Bay, and the north side of the entrance into Lancaster Sound.

1. *Whale-fish Islands*, lat. 69° N., are composed of a very fine-grained, flaggy, black mica schist, composed of black mica in very small plates, occasionally putting on a hornblendic lustre, and minute grains of quartz interstratified with the mica. The softer varieties are cut by the natives into grissets and cooking utensils of various shapes, some of which resemble the camb-stones found in Ireland, which are made from a kind of potstone, abundant in parts of the county of Donegal.

2. *Upernavik*, lat. 72° N., Greenland.—This district is famous for the occurrence of large quantities of plumbago, which is found in a metamorphic rock of the following character:—Fine-grained, amorphous, granitoid rock, composed of minute particles of gray quartz; a honey-coloured felspar, of waxy lustre, of unknown composition; minute particles of red, semitransparent garnet, of conchoidal fracture; and small particles, with occasional large nests, of plumbago. The plumbago occurs both amorphous and in long acicular crystals. Sometimes the rock becomes of a coarser texture, and more crystalline, and the yellow colour of the felspar gives place to a greenish tinge, and it sometimes also becomes a felspar of perfect cleavage, semi-transparent and white.

The dohecahedral crystals of garnet reach the diameter of one inch.

The general character of the rocks near Upernavik is different from that of the rock in which the plumbago is found, and consists of a fine-grained, black mica schist, with very little felspar or quartz, and intersected by thin veins of elvan, composed of quartz and white felspar. The cooking utensils of the natives are made from this fine schist, in preference to any other description of rock.

3. *Woman's Islands.*—These islands, off the west coast of Greenland, are composed of a garnetiferous mica slate, formed of black mica, in layers, with alternating plates composed of white felspar and quartz, and filled with fine garnets, rose-coloured, vitreous in fracture, and transparent.

4. *Cape York*, lat. 76° N., Greenland.—This cape is composed of a fine-grained granite, consisting of quartz, white felspar, with minute specks of a black mineral, of pitchy lustre. Composition not yet determined.

5. *Wolstonholme and Whale Sounds*, lat. 77° N., Greenland.—At Wolstenholme Sound the granitoid rocks of Greenland become converted into mica slate and actinolite slate, of a remarkable character.

The mica slate is composed of large plates of an intimate mixture of black and white mica, the chemical examination of which will doubtless prove of interest. These plates of mica are separated by bands of pure white felspar.

The actinolite slate is dark green, and formed by an almost insensible gradation from the mica slate.

In the low grounds between Wolstenholme and Whale Sounds the granitic rocks cease, and are covered by deposits of fine, red, gritty sandstone, of a banded structure, and a remarkable coarse, white conglomerate.

The boundary between these formations is also marked by the development of masses of dolorite and clayey basalt.

6. *Carey's Islands*, 76° 40′ N., Greenland, lie to the westward of Wolstenholme Sound, and are composed of a remarkable gneissose mica schist, formed of successive thin layers of quartz granules, containing scarcely any felspar, and layers of jet black mica, with occasional facets of white mica.

This mica schist passes into a white gneiss, composed of quartz, white felspar, and black mica, penetrated by veins, coarsely crystallized, of the same minerals. Yellow and white sandstones are also found in small quantity on the islands, reposing upon the granitoid rocks.

Capes Osborn and Warrender, lat. 74° 30′ N., North Devon. The granitoid rocks between these two capes are composed of graphic granite, consisting of quartz (gray) and white felspar; this graphic granite passes into a laminated gneiss, consisting of layers of black mica and white translucent felspar, sparingly mixed with quartz. With the gneiss are interstratified beds of garnetiferous mica slate, consisting of quartz, pale greenish white felspar, black and white mica in minute spangles, and crystals of garnet, rose-coloured, disseminated regularly through the mass. Quartziferous bands of epidotic hornstone occur with the foregoing beds; and the whole series is overlaid by red sandstones, of banded structure, which bear a striking resemblance to those that overlie the granitoid beds of Wolstenholme Sound.

8. *North Somerset*. The granitoid rocks are found again on the west side of the Island of North Somerset, where they form the eastern boundary of Peel's Sound. Boulders of granite are found at a considerable distance (100 miles) to the eastward of the rock *in situ*, as at Port Leopold, Cape Rennell, &c. The general character of the granitic rocks in the north and west of North Somerset are thus described by Captain M'Clintock:—

"Near Cape Rennell we passed a very remarkable rounded boulder of gneiss or granite; it was 6 yards in circumference, and stood near

the beach, and some 15 or 20 yards above it; one or two masses of rounded gneiss, although very much smaller, had arrested our attention at Port Leopold, as then we knew of no such formation nearer than Cape Warrender, 130 miles to the north-east; subsequently, we found it to commence *in situ* at Cape Granite, nearly 100 miles to the south-west of Port Leopold.

"The granite of Cape Warrender differs considerably from that of North Somerset; the former being a graphic granite, composed of gray quartz and white felspar, the quartz predominating; while the latter, or North Somerset granite, is composed of gray quartz, red felspar, and green chloritic mica, the latter in large flakes; both the granite and gneiss of North Somerset are remarkable for their soapy feel."*

To the east of Cape Bunny, where the Silurian limestone ceases, and south of which the granite commences, is a remarkable valley called Transition Valley, from the junction of sandstone and limestone which takes place there. The sandstone is red, and of the same general character as that which rests upon the granitoid rocks at Cape Warrender and at Wolstenholme Sound. Owing to the mode of travelling by sledge on the ice, round the coast, no information was obtained of the geology of the interior of the country, but it appears highly probable that the granite of North Somerset, as well as that of the other localities mentioned, is overlaid by a group of sandstones and conglomerates, on which the Upper Silurian limestones repose directly. A low sandy beach marks the termination of the valley northwards, and on this beach were found numerous pebbles, washed from the hills of the interior, composed of quartzose sandstone, cornelian, and Silurian limestone.

Cape Granite is the northern boundary of the granite, which retains the same character as far as Howe Harbour. It is composed of quartz, red felspar, and dark green chlorite; and is accompanied with gneiss of the same composition. I have in my possession a specimen of this granite, found as a pebble at Graham Moore Bay, Bathurst Island, S.W., a locality 135 knots distant from Cape Granite, to the north-west.

9. *Bellot's Straits*, lat. 72° N., separate North Somerset from Boothia Felix. The "Fox" Expedition wintered here in 1858, and had abundant means of ascertaining the geological structure of the neighbourhood. The junction of the granitoid and Silurian rocks occurs in these straits, the low ground to the east being horizontal beds of Silurian limestone, while on the west the granite hills of West Somerset rise to a height of 1600 feet above the narrow straits. The granite here is of three varieties:—

α. Blackish gray, fine-grained, gneissose granite, composed of quartz, white felspar, and large quantities of fine grains and flakes of hornblende, passing into black mica. The gneissose beds of this granite dip 13 S. E.

β. A red granite, graphic texture, composed of quartz and red felspar, coarse-grained.

* "Journal of the Royal Dublin Society," 1857.

γ. Syenite, composed of honey-yellow felspar and hornblende, in very large crystals, the felspar passing into red and pink, and the whole rock mass penetrated by veins of the same material, but fine grained. This variety of igneous rock was met with principally at Pemmican Rock, western inlet of Bellot's Straits.

Large quantities of hornblende are also met with at Leveque Harbour, Bellot's Straits, composed of facetted crystals, agglutinated together into large masses, forming a crystalline, hornblendic gneiss.

10. *Pond's Bay, Baffin's Bay*, lat. 72°, 40′ N.—In this locality a quartziferous black mica schist underlies the Silurian Limestone, interstratified with gneiss and quartziferous quartz rock, all in beds, inclined 38° W. S.W. (true).

11. *Montreal Island*, mouth of the Fish River, lat. 67° 45′ N.—The granitoid rocks, which everywhere in the Arctic Archipelago underlie the Silurian Limestone, appear at Montreal Island as a gneiss, composed of bands of felspar (pink) and quartz (¼ in. thick), separated by thin plates, composed altogether of black mica, the whole rock exhibiting the phenomena of foliation in a marked degree.

The east side of King William's Island, though composed of Silurian Limestone, like the rest of the island, is strewed with boulders of black and red micaceous gneiss, like that of Montreal Island, and black metamorphic clay slate, in which the crystals of mica are just commencing to be developed. It is probable that the granitoid rocks appear at the surface, somewhat to the eastward of this locality.

12. *Prince of Wales Island*, west of Peel Sound.—The granitoid rocks extend across Peel Sound into Prince of Wales' Island, in the form of a dark syenite, composed of quartz, greenish-white felspar, passing into yellow, and hornblende. This rock is massive and eruptive at Cape M'Clure, lat. 72° 51′ N., and occasionally gneissose, as at lat. 72° 13′ N. Between these two points, at lat. 72° 37′ N., a limestone bluff occurs, containing the characteristic Silurian fossils, and is succeeded, at 70° 40′, by a ferruginous limestone, bright red, and a few beds of fine red sandstone, like those observed by M'Clintock at Transition Valley, North Somerset. The entire western portion of Prince of Wales' Land is composed of Silurian limestone, which, in the extreme west, at Cape Acworth, becomes chalky in character, resembling the peculiar Silurian limestone found on the west side of Boothia Felix.

II. The Silurian Rocks.

The Silurian rocks of the Arctic Archipelago rest everywhere directly on the granitoid rocks, with a remarkable red sandstone, passing into coarse grit for their base. This sandstone is succeeded by ferruginous limestone, which rapidly passes into a fine grayish-green earthy limestone, abounding in fossils, and occasionally into a chalky limestone, of a cream colour, for the most part devoid of fossils. The average dip of the Silurian limestone varies from 0° to 5° N.W., and it forms occasionally high cliffs, and occasionally low, flat plains, terraced by the action of the ice as the ground rose from beneath the sea.

The general appearance of the rocks is similar to the Dudley lime-

stone, and would strike even an observer who was not a geologist. This resemblance to the Upper Silurian beds extends to the structure of the rocks on the large scale. Alternations of hard limestone and soft shale, so characteristic of the Upper Silurian beds of England and America, arranged in horizontal layers, give to the cliffs around Port Leopold the peculiar appearance which has been described by different Polar navigators as "buttress-like," "castellated." This appearance is produced by the unequal weathering of the cliff, which causes the hard limestone to stand out in bands. Excellent sketches of this remarkable appearance, drawn by Lieutenant Beechy, are figured at page 35 of Parry's "First Voyage," Hecla and Griper, 1819–20.

The western side of King William's Island (now, alas! invested with so sad an interest) is a good example of the low, terraced form which the limestone rocks assume at times.

The following lists contain the names of the principal fossils brought home by Captain M'Clintock:—

I. GARNIER BAY (LAT. 74° N.; LONG. 92° W.)

1. *Cyathophyllum helianthoides*, several specimens.
2. *Heliolites porosa*. Garnier Bay. Another specimen from near Cape Bunny.
3. Specimens of Carnelian, Gneiss, Chalcedony, &c., &c., from the shingle near Cape Bunny.
4. *Cromus Arcticus*, several specimens.
5. *Atrypa phoca* (Salter).
6. *Atrypa reticularis*.
7. Brachiopoda on slab (various).
8. Cyathophyllum.
9. *Columnaria Sutherlandi* (Salter). Several specimens.

II. PORT LEOPOLD (LAT. 73° 50′ N.; LONG. 90° 15′ W.)

1. Limestone containing numerous fossils of the Upper Silurian type: *Calamopora Gothlandica*, Goldf. *Rhynchonella cuneata?* Dalm. *Cyathophyllum*, sp.
2. Dark earthy limestone, containing multitudes of the *Loxonema M'Clintocki*, as casts —1100 feet above sea-level on North-east Cape.
3. Fine specimens of Selenite from shaly beds in cliff.
4. Fibrous gypsum from same.

III. GRIFFITH ISLAND (LAT. 74° 35′ N.; LONG. 95° 30′ W.)

1. Beautiful specimens of the *Cromus Arcticus*. Pl. VI., Fig. 5, Journ. R. D. S., vol. i.
2. *Orthoceras Griffithi*. Pl. V., Fig. 1. Journ. R. D. S., vol. i.
3. An Orthoceras, with lateral siphuncle, and simple circular outline of septa.
4. *Loxonema Rossi*. Pl. V., Figs. 6, 8, 9, 10, 11, Journ. R. D. S., vol. i.
5. Numerous specimens of crinoidal limestone.
6. *Strophomena Donnetti* (Salter). Sutherland's Voyage. Pl. V., Figs. 11, 12.
7. *Atrypha phoca* (Salter). Pl. V., Figs. 3, 4, 7 (Journ. R. D. S., vol. i.), and a ribbed Atrypa, not identified with European species, and undescribed.
8. An undescribed bryozoan Zoophyte. Pl. VII., Fig. 6. Journ. R. D. S.
9. *Calophyllum Phragmoceras* (Salter). Sutherland. Pl. VI., Fig. 4.
10. *Syringopora geniculata*.
11. An undescribed species of *Macrocheilus*.

IV. BEECHEY ISLAND (LAT. 74° 40′ N.; LONG. 92° W.)

1. Orthoceras (species).
2. Great multitudes of *Atrypa phoca*, forming, in fact, a dark-coloured earthy Atrypa limestone.
3. With these were associated many species of Loxonema, sometimes so abundant as to form a pale pink and whitish Loxonema limestone.

4. A species of ribbed Atrypa.
5. Crinoidal limestone in abundance.
6. *Syringopora reticulata.*
7. *Calophyllum phragmoceras* (Salter). Sutherland. Pl. VI., Fig. 4.
8. *Cyathophyllum cæspitosum.*
9. ,, *articulatum* (Edwardes and Haime).
10. *Calamopora Gothlandica.*
11. ,, *alveolaris.*
12. *Favistella Franklini* (Salter). Sutherland. Pl. VI., Fig. 3.
13. *Clysiophyllum Salteri.* Sutherland. Pl. VI., Fig. 7.
14. *Cyathophyllum* (species).
15. *Loxonema*, described by Mr. Salter in Sutherland's "Voyage to Wellington Channel. Pl. V., Fig. 19.

This is a fine slab of limestone, almost altogether composed of the remains of *Loxonema Salteri*, No. I., and *Atrypa phoca.* It appears to have been quietly deposited at the bottom of a deep submarine depression, swarming with Pyramidellidæ and deep-water Brachiopoda. The physical conditions indicated by the fossils are also rendered probable by the rock itself, which consists of fine gray limestone, subcrystalline, and intimately blended with the finest and most delicate description of mud, such as could only be found where the water was deep, and all currents far removed.

V. CORNWALLIS ISLAND, ASSISTANCE BAY (LAT. 74° 40′ N.; LONG. 94° W.)

1. *Orthoceras Ommanneyi* (Salter). Sutherland. Pl. V., Figs. 16, 17.
2. *Pentamerus conchidium* (Dalman). Sutherland. Pl. V., Figs. 9, 10.
3. Pentamerus limestone.
4. *Cromus Arcticus.*
5. *Cardiola Salteri.* Pl. VII., Fig. 5. Journ. R. D. S., vol. i.
6. *Syringopora geniculata.*

VI. CAPE YORK, LANCASTER SOUND (LAT. 73° 50′ N.; LONG. 87° W.)

A specimen of the same fossil coral which I have named, doubtfully, from Beechey Island, as Favosites or *Calampora Gothlandica*; it is not impossible, however, that it is not a Calamopora at all, but a species of Chætetes.

VII. POSSESSION BAY, SOUTH ENTRANCE INTO LANCASTER SOUND (LAT. 73° 30′ N.; LONG. 77° 20′ W.)

Specimens of brown earthy limestone, with a fetid smell when struck with a hammer; resembles closely the limestone of Cape York, Lancaster Sound.

VIII. DEPOT BAY, BELLOT'S STRAITS (LAT. 72° N.; LONG. 94° W.)

1. Maclurea.
2. *Cyathophyllum helianthoides* (Goldfuss).

The limestone at this locality is white and saccharoid, with large rhombohedral crystals of calc-spar.

IX. CAPE FARRAND, EAST SIDE OF BOOTHIA (LAT. 71° 38′ N.; LONG. 93° 35′ W.)

1. *Atrypa phoca* (Salter).
2. *Loxonema Rossi.* Journ. R. D. S., vol. i., Pl. V.
3. Atrypa (ribbed sp.)
4. *Calamopora Gothlandica* (Goldfuss).
5. Cyrtoceras, sp.

The rock at this locality is a gray mud limestone.

X. WEST SHORE OF BOOTHIA (LAT. 70° TO 71° N.), CONTAINING THE MAGNETIC POLE.

1. *Atrypa phoca* (Salter).
2. *Loxomena Rossi.* Journ. R. D. S., vol. i., Pl. V.
3. *Favistella Franklini* (Salter). Journ. R. D. S., vol. i., Pl. XI.

4. *Loxonema Salteri* (Sutherland). Pl. V., Fig. 18.

The cream-coloured, chalky limestone, found on the west side of Prince of Wales' Island, here occurs, and is generally destitute of fossils, like that of Prince of Wales' Land.

XI. FURY POINT (LAT. 72° 50′ N.; LONG. 92° W.)

1. *Cromus Arcticus.* Journ. R. D. S., vol. i., Pl. VI.
2. Maclurea, sp.
3. *Mya rotundata ?*
4. *Stromatopora concentrica.*
5. *Cyathophyllum helianthoides* (Goldfuss).
6. *Petraia bina.*
7. *Calamopora Gothlandica* (Goldfuss).
8. *Favosites megastoma ?*
9. *Cyathophyllum cespitosum.*
10. *Favistella Franklini* (Salter). Sutherland. Pl. VI., Fig. 3.
11. *Strephodes Austini* (Salter). Sutherland. Pl. VI., Fig. 6.
12. *Atrypa phoca* (Salter).

The limestone here is of the same gray earthy aspect as at Beechey Island and Port Leopold.

XII. PRINCE OF WALES' LAND (LAT. 72° 38′ N.; LONG. 97° 15′ W.)

1. Cyathophyllum, sp.
2. *Calamopora Gothlandica.*
3. *Stromatopora concentrica.*

These fossils occur in gray earthy limestone, near its junction with the red arenaceous limestone already described.

XIII. WEST COAST OF KING WILLIAM'S ISLAND.

1. *Loxonema Rossi.* Journ. R. D. S., vol. i., Pl. V.
2. *Catenopora escharoides.*
3. Orthoceras, sp.
4. Maclurea, sp.
5. Atrypa, sp.
6. *Syringopora geniculata.*
7. Clisiophyllum, sp.
8. *Orthis elegantula.*

III. The Carboniferous Rocks.

The Upper Silurian limestones, already described, are succeeded by a most remarkable series of close-grained, white sandstones, containing numerous beds of highly bituminous coal, and but few marine fossils,—in fact, the only fossil shell found in these beds, so far as I know, in any part of the Arctic Archipelago, is a species of ribbed Atrypa, which I believe to be identical with the *Atrypa fallax*, of the Carboniferous Slate of Ireland. These sandstone beds are succeeded by a series of blue limestone beds, containing an abundance of the marine shells commonly found in all parts of the world where the carboniferous deposits are at all developed. The line of junction of these deposits with the Silurians, on which they rest, is N. E. to E. N. E. (true). Like the former, they occur in low, flat beds, sometimes rising into cliffs, but never reaching the elevation attained by the Silurian rocks in Lancaster Sound.

The following lists contain the principal fossils and specimens presented to the Royal Dublin Society by Captain M'Clintock and by Captain Sir Robert M'Clure:—

Coal, sandstone, clay ironstone, brown hematite, were found along a line stretching E. N. E. from Baring Island, through the south of Melville Island, Byam Martin's Island, and the whole of Bathurst Island. Carboniferous limestone, with characteristic fossils, was found along the north coast of Bathurst Island, and at Hillock Point, Melville Island.

The discovery of coal in these islands is due to Parry; but the evidence of the extent and quantity in which it may be found was obtained during the Expeditions of Austin and Belcher. In addition to the localities surveyed by himself, Captain M'Clintock has given me specimens of the coal found at other places by other explorers, and it is from a comparison of all these specimens that I have ventured to lay down the outcrop of the coal-beds, which agrees remarkably well with the boundary of the formations laid down from totally different data.

I. HILLOCK POINT, MELVILLE ISLAND (LAT. 76° N.; LONG. 111° 45′ W.)

Productus sulcatus. Journ. R. D. S., vol. i., Pl. VII., Figs. 1, 2, 3, 4, 7.
Spirifer Arcticus. Journ. R. D. S., vol. i., Pl. IX.

II. BATHURST ISLAND, NORTH COAST, CAPE LADY FRANKLIN? (LAT. 76° 40′ N.; LONG. 98° 45′ W.)

Spirifer Arcticus. Journ. R. D. S., vol. i., Pl. IX., Fig. 1.
Lithostrotion basaltiforme.

III. BALLAST BEACH, BARING ISLAND (LAT. 74° 30′ N.; LONG. 121° W.)

1. Wood fossilized by brown hematite; structure quite distinct.
2. Cone of the spruce fir, fossilized by brown hematite.

IV. PRINCESS ROYAL ISLANDS, PRINCE OF WALES' STRAIT, BARING ISLAND (LAT. 72° 45′ N.; LONG. 117° 30′ W.)

1. Nodules of clay ironstone, converted partially into brown hematite.
2. Native copper in large masses, procured from the Esquimaux in Prince of Wales's Strait.
3. Brown hematite, pisolitic.
4. Grayish-yellow sandstone, same as Cape Hamilton and Byam Martin's Island.
5. *Terebratula aspera* (Schlotheim). Journ. R. D. S., vol. i., Pl. XI., Fig. 4.

This interesting Brachiopod was found in limestone by Captain M'Clure, at the Princess Royal Islands, in the Prince of Wales' Strait, between Baring Island and Prince Albert Land. I have no hesitation in pronouncing it to be identical with Schlotheim's fossil, which is found in the greatest abundance at Gerolstein, in the Eifel. Banks' Land, or Baring Island, is composed of sandstone, similar to that at Byam Martin's Island, and at the Bay of Mercy. This sandstone contains beds of coal, apparently the continuation of the well-known coal beds of Melville Island. It is a remarkable fact, that these carboniferous sandstones *underlie* beds of undoubtedly the carboniferous limestone type, and that at Byam Martin's Island, where fossils are found in this sandstone, they are allied to *Atrypa fallax* and other forms characteristic of the

lower sandstones of the carboniferous epoch. It is, therefore, highly probable that the coal-beds of Melville Island are very low down in the series, and do not correspond in geological position with the coal-beds of Europe, which rest on the summit of the carboniferous beds. It is interesting to find at Princess Royal Island, where, from the general strike of the beds, we should expect to find the Silurian limestone underlying the coal-bearing sandstones, that this limestone does occur, and contains a fossil, *T. aspera*, eminently characteristic of the Eifelian beds of Germany, which form, in that country, the upper Silurian strata.

V. **CAPE HAMILTON,** BARING ISLAND (LAT. 74° 15′ N.; LONG. 117° 30′ W.)

1. Grayish-yellow sandstone, like that found *in situ* in Byam Martin's Island.
2. *Coal.*—The coal found in the Arctic regions, excepting that brought from Disco Island, West Greenland, which is of tertiary origin, presents everywhere the *same* characters, which are somewhat remarkable. It is of a brownish colour and lignaceous texture, in fine layers of brown coal and jet-black glossy coal interstratified in delicate bands not thicker than paper. It has a woody ring under the hammer, recalling the peculiar clink of some of the valuable gas coals of Scotland. It burns with a dense smoke and brilliant flame, and would make an excellent gas coal; and, in fact, it resembles in many respects some varieties of the coal which has acquired such celebrity in the Scotch and Prussian law courts, under the title of the Torbane Hill mineral.

VI. **CAPE DUNDAS,** MELVILLE ISLAND (LAT. 74° 30′ N.; LONG. 113° 45′ W.)

Fine specimens of coal.

VII. **CAPE SIR JAMES ROSS,** MELVILLE ISLAND (LAT. 74° 45′ N.; LONG. 114° 30′ W.)

Sandstone passing into blue quartzite.

VIII. **CAPE PROVIDENCE,** MELVILLE ISLAND (LAT. 74° 20′ N.; LONG. 112° 30′ W.)

A specimen of crinoidal limestone, apparently similar to that occurring in Griffith's Island, from which, however, it could not have been brought by the present drift of the floating ice, as the set of the currents is constant from the west. If brought to its present position by ice, it must have been under circumstances differing considerably from those now prevailing in Barrow's Strait.

Yellowish-gray sandstone.

Clay ironstone passing into pisolitic hematite.

IX. **WINTER HARBOUR,** MELVILLE ISLAND (LAT. 74° 35′ N.; LONG. 110° 45′ W.)

Fine yellow and gray sandstone.

X. **BRIDPORT INLET,** MELVILLE ISLAND (LAT. 75° N.; LONG. 109° W.)

Coal, with impressions of Sphenopteris.

Ferruginous spotted white sandstone.

Clay ironstone, passing into brown hematite.

XI. SKENE BAY, MELVILLE ISLAND (LAT. 75° N.; LONG. 108° W.)

Bituminous coal, with finely divided laminæ, associated with brown crystalline limestone, with cherty beds, and gray-yellowish sandstone, passing into brownish red sandstone.

XII. HOOPER ISLAND, LIDDON'S GULF, MELVILLE ISLAND (LAT. 75° 5′ N.; LONG. 112° W.)

Nodules of clay ironstone, very pure and heavy, associated with ferruginous fine sandstone and coal of the usual description.

The hill-tops and sides along the south shore of Liddon's Gulf, and as far as Cape Dundas, are generally bare, composed of frozen mud, arising from the disintegration of shale, the annual dissolving snows washing them down and giving them a rounded form. The southern slopes generally support vegetation. Fragments of coal are very frequently met with, and at the mouth of a ravine on the south shore of Liddon's Gulf, Captain M'Clintock saw plenty, of very good quality; it contained a considerable quantity of pyrites or *bisulphuret* of iron.

XIII. BYAM MARTIN'S ISLAND (LAT. 75° 10′ N.; LONG. 104° 15′ W.)

Yellowish-gray sandstone, *in situ*, containing a ribbed Atrypa, allied to the *A. primipilaris* of V. Buch, and the *A. fallax* of the Carboniferous rocks of Ireland.

Reddish limestone, with broken fragments of shells, of the same description of Brachiopod as the last.

Coal of the usual description.

Fine-grained red sandstone, passing into red slate.

Scoriaceous hornblendic trap (boulders).

The sandstone of Byam Martin's Island is of two kinds—one red, finely stratified, passing into purple slate, and very like the red sandstone of Cape Bunny, North Somerset, and some varieties of the red sandstone and slate found between Wolstenholme Sound and Whale Sound, West Greenland, lat. 77° north. The other sandstone of Byam Martin's Island is fine, pale-greenish, or rather grayish-yellow, and not distinguishable in hand specimens from the sandstone of Cape Hamilton, Baring Island. It contains numerous shells and casts of a terebratuliform Brachiopod, closely allied to the *Terebratula primipilaris* of Von Buch, found abundantly at Gerolstein in the Eifel. On the whole, I incline to the opinion that the sandstones, limestone, and coal of Byam Martin's Island, and the corresponding rocks of Melville Island, Baring Island, and Bathurst Island, are low down in the Carboniferous System, and that there is in these northern coal-fields no subdivision into red sandstone, limestone, and coal-measures, such as prevail in the west of Europe. If the different points where coal was found be laid down on a map, we have in order, proceeding from the south-west: Cape Hamilton, Baring Island; Cape Dundas, Melville Island, south; Bridport Inlet and Skene Bay, Melville Island; Shomberg Point, Graham Moore Bay, Bathurst Island; a line joining all these points is the outcrop of

the coal-beds of the south of Melville Island, and runs E. N. E. At all the localities above mentioned, and, indeed, in every place where coal was found, it was accompanied by the grayish-yellow and yellow sandstone already described, and by nodules of clay ironstone, passing into brown hematite, sometimes nodular, and sometimes pisolitic in structure.

XIV. GRAHAM MOORE'S BAY, BATHURST ISLAND (LAT. 75° 30'; LONG. 102° W.)

Coal of the usual quality.

At Cape Lady Franklin, and at many other localities along the north shore of Bathurst Island, carboniferous fossils in limestone, clay ironstone balls passing into brown hematite, cherty limestone, and earthy fossiliferous limestone, with the same species of *Atrypa* as at Byam Martin's Island, were found in abundance by Sherard Osborn, Esq., Commander of H. M. S. Pioneer, in whose Journal the following note respecting them may be found:—"The above collection was delivered over to Captain Sir Edward Belcher, C. B., by Commander Richards, at 2 P. M., on 7th Nov. 1853."*

It is to be hoped that they may soon be made available for the elucidation of the geology of this most interesting portion of the Arctic discoveries.

XV. BATHURST ISLAND, BEDFORD BAY (LAT. 75° N.; LONG. 95° 50' W.)

In this locality abundance of vesicular scoriaceous trap-rocks were found by Captain M'Clintock; they appear to me to be the representatives of the volcanic rocks found everywhere at the commencement of the Carboniferous period.

XVI. CORNWALLIS ISLAND, M'DOUGALL BAY.

1. *Syringopora geniculata.* Journ. R. D. S., vol. i., Pl. XI., Fig. 2.
2. *Cardiola Salteri.* Journ. R. D. S., vol. i., Pl. VII., Fig. 5.

The Syringopore found at Cornwallis Island appears to be identical with the variety of the Irish Carboniferous *S. geniculata,* in which the coralites are at a distance from each other, somewhat exceeding their diameters, and in which the connecting tubes are about two diameters apart.

A question of very considerable geological interest is raised by the occurrence together of corals, in the same locality, of Silurian and Carboniferous forms.

I entertain no doubt of their being *in situ*, and occurring in the same beds, for the following reasons:—

1st. The Syringopores of Griffith's Island were found at an elevation of 400 feet above the sea, and, therefore, could not be brought by drifting ice.

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* *Vide* "Arctic Expeditions," 1854-5, p. 254.

2nd. The specimens were apparently of the same texture and composition as the native rock, whenever the latter was visible from under the snow.

3rd. I do not believe in the lapse of a long interval of time between the Silurian and Carboniferous deposits,—in fact, in a Devonian period.

4th. The same blending of corals has been found in Ireland, the Bas Boulonnais, and in Devonshire, where Silurian and Carboniferous forms are of common occurrence in the same localities.

5th. In the Carboniferous beds proper of Melville Island, and Bathurst Island, there were not found, so far as I am aware, any corals of the same character as those at Griffith's Island, Cornwallis Island, and Beechy Island, which could give a supply to be drifted to the latter localities in a Pleistocene sea. It is plain, from the height at which the corals were found, that, if they were brought to their present localities by ice, it must have been during the period known as Post-tertiary, as the present conditions of drift-ice in Barrow's Straits do not permit us to suppose them to have been placed where we now find them by existing causes.

The occurrence of coal-beds in such high latitudes has been speculated on by many geologists, in my opinion not very satisfactorily; as it is very difficult to conceive how, even if the question of temperature were settled, plants even of the Fern and Lycopodium type could exist during the darkness of the long winter's night at Melville Island. This difficulty is increased by the facts made known to us by the discovery of Ammonites and Lias fossils in Prince Patrick's Island by Captain M'Clintock.

IV.—The Lias Rocks.

Many years ago, it was asserted by Lieutenant Anjou, of the Russian Navy, that Ammonites had been found by him in the cliffs on the south shore of the Island of New Siberia, off the north coast of Asia, in lat. 74°N. This statement, which was published in Admiral von Wrangel's Journal, attracted but little attention, until it was confirmed, as far as probability of such fossils occurring at so high a latitude is concerned, by the remarkable discovery of similar fossils, by Captain M'Clintock, in lat. 76° 20′ N., at Point Wilkie, in Prince Patrick's Island.

In a paper published by the Royal Dublin Society, in the first volume of their Journal, p. 223, Captain M'Clintock thus describes the finding of these fossils:—

"After returning to Cape de Bray, we took up the provisions that the officer after whom it is called had left for us, and crossed the strait to Point Wilkie; reached it on the 14th May. This traverse was the more difficult from the great load upon our sledge, and the unfavourable state of the ice and snow. The freshly fallen snow was soft and deep, and beneath it the older snow lay in furrows across our route, hardened and polished by the winter gales and drifts, so that it resembled marble.

"On landing, I found the beach low, composed of mud, with the footprints of animals frozen in it. A few hundred yards from the beach there are steep hills, about 150 feet in height, and upon the sides of

these, in reddish-coloured limestone, casts of fossil shells abound. Inland of these, the ordinary pale carboniferous sandstone and cherty limestone reappeared. The fossils are all small, and of only a few varieties, some being ammonites, but the greater part bivalves. They differed from any I had met with before, and the rock was almost brick-red; I picked up what appeared to be fossil bone (*Ichthyosaurus ?*), only part of it appearing out of the fragment of the rock.

"Point Wilkie appears to be an isolated patch of liassic age, resting upon carboniferous sandstones and limestones, with bands of chert, of the same age as the limestones and sandstones of Melville Island. The eastern shore of Intrepid Inlet is composed of this formation; while the western, rising into hills and terraces, is of the underlying Carboniferous epoch. At the western side of Intrepid Inlet I found upon the ice a considerable quantity of white asbestos, but did not ascertain from whence it had been brought."

The fossils thus found *in situ*, I have no doubt, belong to the Liassic period, and as their geological interest is indubitable, I offer no apology for inserting here the following description, written by me on Captain M'Clintock's return to Dublin from his third Arctic Expedition:—

I. WILKIE POINT, PRINCE PATRICK'S LAND (LAT. 76° 20′ N.; LONG. 117° 20′ W.)

LIAS FOSSILS.

(*a*) *Ammonites M'Clintocki*, Journ. R. D. S., vol. i., Pl. IX., Figs. 2, 3, 4.
Monotis septentrionalis, Journ. R. D. S., vol. i., Pl. IX., Figs. 6, 7.
Pleurotomaria, sp., Journ. R. D. S., vol. i., Pl. IX., Fig. 8.
Cast of some Univalve, Journ. R. D. S., vol. i., Pl., IX., Fig. 7.
Nucula, sp.

(*a*) Ammonites M'Clintocki (Haughton).—*Testâ compressâ, carinatâ, anfractibus latis, lateribus complanatis, transversim undato-costatis; costis simplicibus, juxtâ marginem interiorem levigatis; dorso carinato acuto; aperturâ sagittatâ, compressa, antice carinatâ; septis lateribus 4-lobatis.*

This fine Ammonite resembles several species common in the upper Lias of the Plateau de Larzac, Sevennes, in France. It approaches *A. concavus* of the lower Oolite, but is distinguished by having only four lobes on the lateral margins of the septa, and by its showing no tendency to a tricarinated keel. The following measurements give an exact idea of its form, as compared with that of the species mentioned:—

	Diameter. Inches.	Width of last Spire. Diam. = 100.	Thickness of last Spire.	Overlapping of last Spire.	Width of Umbilic.
A. M'Clintocki, . .	1·83	$\frac{51}{100}$	$\frac{24}{100}$	$\frac{30}{100}$	$\frac{20}{100}$
A. concavus, . . .	2·95	$\frac{50}{100}$	$\frac{24}{100}$	$\frac{19}{100}$	$\frac{16}{100}$

The principal difference here observable is in the somewhat greater size of *A. concavus*, and the larger umbilic of *A. M'Clintocki*. It certainly resembles this well-known Ammonite very closely; and it appears to me difficult to imagine the possibility of such a fossil living in a frozen, or even a temperate sea.

The discovery of such fossils *in situ*, in 76° north latitude, is calculated to throw considerable doubt upon the theories of climate which would account for all past changes of temperature by changes in the relative position of land and water on the earth's surface. No attempt, that I am aware of, has ever been made to calculate the number of degrees of change possible in consequence of changes of position of land and water; and from some incomplete calculations I have myself made on the subject, I think it highly improbable that such causes could have ever produced a temperature in the sea at 76° north latitude, which would allow of the existence of Ammonites, especially Ammonites so like those that lived at the same time in the tropical warm seas of the south of England and France, at the close of the Liassic, and commencement of the lower Oolitic period.

During the course of the same Arctic Expedition in which these organic remains were found, Captain Sir Edward Belcher discovered in some loose rubble, of which a cairn was built on Exmouth Island (lat. 77° 12′ N., long. 96° W.), vertebral bones of apparently some Liassic Enaliosaurian. All doubt as to the reality of this discovery, and all idea of accounting for the occurrence of such remains by drift, must be abandoned, as the fossils found by M'Clintock were unquestionably *in situ*, and it is impossible to evade the consequences that follow to geological theory from their discovery.

Captain Sherard Osborn also found broken vertebræ of a Teleosaurus, 150 feet up Rendezvous Hill, Byam Martin's Channel, at the N. W. extreme of Bathurst Island: they were certainly *in situ*.

I am well aware that the question of light in the Arctic seas, will be disposed of by some geologists, who will remind us, that the Saurians, and probably the Ammonites, were endowed with a complicated optical apparatus, rendering them capable of using their eyes, not only for the distinct vision of objects differing greatly in distance, but also of using them under widely differing conditions of light and darkness—and I readily admit the force of such observations.

But what are we to say as to the question of temperature? It was certainly necessary for an Ammonite to have a sea free from ice, on which to float and bask in the pale rays of the Arctic sun—and, therefore, I claim a temperature for those seas at least similar to that which now prevails in the British Islands; and I may add that the Ammonite, from its habits, was essentially dependent on the temperature of the air, as well as on that of the water.

There is at present a difference of 49°·5 F. between the mean annual temperature of Point Wilkie and Dublin; and if this change of temperature be supposed to be caused by a change of the relative positions of land and water, the temperature of Dublin, or of some place on

the same parallel of latitude, must be supposed to be raised to 99°·5 F.; while the temperature of the thermal equator will exceed 124°! A theory that involves such a result, which must be considered as a minimum, certainly requires proof, as it is probable that the Ammonite required a finer climate than that of Britain for the full enjoyment of his existence.

The theory of central heat, also, appears to me to be open to the same objection, as a mode of explaining this remarkable geological fact; for it will simply add a constant to our present climates, leaving the differences to remain, as at present, to be accounted for by latitude, and distribution of land and water. The astronomical theory of Herschel, which would account for former changes of climate by changes in the radiating power of the sun, would only increase the temperature at each latitude, leaving the differences as at present.

The only speculation with which I am acquainted, which is capable of solving this *opprobrium geologicorum*, is the hypothesis of a change in the axis of rotation of the earth; the admission of which, as a geological possibility, is mathematically demonstrable, and which has recently had some singular evidence in its favour advanced by geologists.

In 1851 I brought forward, at the Geological Society of Dublin, a case of angular fragments of granite occurring in the carboniferous limestone of the county of Dublin; and explained the phenomena by the supposition of the transporting power of ice. In 1855 Professor Ramsay laid before the Geological Society of London a full and detailed theory of glaciers and ice as agents concerned in the formation of a remarkable breccia, of Permian age, occurring in the central counties of England; and, still more recently, the same agent has been employed by the Geological Surveyors of India to account for the transport of materials at geological periods long antecedent to those in which ice transport is commonly supposed to have commenced. The motion of the earth's axis would reconcile all the facts known; and it must be regarded as a geological desideratum to determine its amount and direction, and to assign the cause of such a movement. The solution of this problem I regard as quite possible.

It is well worthy of remark that the arguments from the occurrence of coal-plants and Ammonites strengthen each other, the coal-plants rendering the question of *light*, and the Ammonites that of *heat*, insuperable objections to the admission of any received geological hypothesis to account for the finding of such remains *in situ*, in latitudes so high as those of Melville Island, Prince Patrick's Island, and Exmouth Island.

V. The Superficial Deposits.

The surface of the ground, where exposed, throughout the Arctic Archipelago, does not appear to be covered with thick deposits of clay or gravel, such as are found generally in the north of Europe, and referred by geologists to what they call "the Glacial Epoch." There are not, however, wanting abundant evidences of the transport of drift ma-

terials; and there is some good evidence, collected by Captain M'Clintock, of the direction in which the drift was moved.

Specimens of granite, which I have no hesitation in referring to the characteristic granite of the west side of North Somerset, were found at Leopold Harbour (North Somerset), and at Graham Moore Bay (Bathurst Island). One of these localities is N. E., and the other N. W. of the granite of North Somerset; from which I infer that there was no constant prevailing direction for the drift-ice that carried these boulders, but that they were transported to the northward in various directions, according to the varying motion of the currents that moved the ice. The boulder of granite at Port Leopold is 100 miles N. E. of the granite which gave origin to it; and the specimens from Graham Moore Bay are 190 miles to the north-west of their source.

At Cape Rennell (North Somerset), in a direction intermediate between the two former directions, a remarkable boulder of the same granite was found, confirming the general direction of the transporting force from south to north. Its position and size are thus recorded by Captain M'Clintock:—"Near Cape Rennell we passed a very remarkable rounded boulder of gneiss or granite; it was six yards in circumference, and stood near the beach, and some fifteen or 20 yards above it. One or two masses of rounded gneiss, although very much smaller, had arrested our attention at Port Leopold."

It is well known that Captain Sir Robert M'Clure brought home specimens of pine trees found in the greatest abundance in the ravines on the west coast of Baring Island. One of his specimens, preserved in the Museum of the Royal Dublin Society, measures fifteen inches by twelve inches, and contains three knots, that prove it formed a portion of the stem high above its root. The bark is not found on this specimen, which does not represent the full thickness of the tree. I have estimated that this fragment contains seventy rings of annual growth.

Similar remains were found by Captain M'Clintock and Lieutenant Mecham in Prince Patrick's Island; and in Wellington Channel by Sir Edward Belcher. On the coast of New Siberia, Lieutenant Anjou found a clay cliff containing stems of trees still capable of being used as fuel. The original observers all agree in thinking that these trees grew where they are now found; and Captain Osborn, in mentioning Sir Roderick I. Murchison's opinion that they are drift timber, justly adds the remark that a sea sufficiently free from ice to allow of their being drifted from the south would indicate also a climate sufficiently mild to allow of their having grown upon the land where they now occur. Mr. Hopkins, in his anniversary address, as President of the Geological Society of London, has published a remarkable geological speculation, which would account for the facts above mentioned.*

So far as the evidence of drift boulders is concerned, I have shown that the direction of the currents was from the south; a fact which falls in with the drift theory, so far as it goes.

* "Journal of the Geological Society of London," vol. viii., p. lxiv.

We cannot, however, dissociate these trees from the facts connected with the distribution of the remains of the Siberian mammoth in Asia and America. It is now known that this elephant was provided with a warm fur, and that his food was of a kind which grows even now in Northern Siberia; so that the drift theory, which was formerly supposed necessary to account for the occurrence of these remains, has now been quietly dropped, *sub silentio*, by the geologists. Many other drift theories have, in like manner, lived their short day, and gone the way of all false hypotheses; among others, the drift theory of the origin of coal. Further investigation may show that the glacial epoch of Europe was one of a very different character in Asia and America, and that, while glaciers clothed the sides of Snowdon and Lugnaquillia, pine forests flourished in the Parry Islands, and the Siberian elephants wandered on the shores of a sea washed by the waves of an ocean that carried no drifting ice.

There is abundant evidence, however, that the Arctic Archipelago was submerged in very recent geological periods; for we know that subfossil shells, of species that now inhabit the waters of the neighbouring seas, are found at considerable heights throughout the whole group of islands. M'Clure found shells of the *Cyprina islandica* at the summit of the Coxcomb range, in Baring Island, at an elevation of 500 ft. above the sea level; Captain Parry also has recorded the occurrence of *Venus* (probably *Cyprina islandica*) on Byam Martin's Island; and in the recent voyage of the Fox, Dr. Walker, the Surgeon of the Expedition, found the following subfossil shells at Port Kennedy, at elevations from 100 to 500 ft.:—

1. Saxicava rugosa.
2. Tellina proxima.
3. Astarte Arctica (Borealis).
4. Mya Uddevallensis.
5. Cyprina Islandica.
6. Cardium.
7. Mya truncata.
8. Buccinum undatum.
9. Acmea testudinalis.
10. Balanus Uddevallensis.

At the same place a portion of the palate bone of a whale was found, at an elevation of 150 ft.

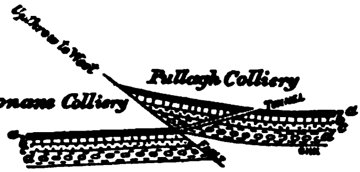
All these facts indicate the former submergence of the Arctic Archipelago, but this submergence must have been anterior to the period when pine forests clothed the low sandy shores of the slowly emerging islands, the remains of which forests now occupy a portion, at least 100 ft., above high water mark.

Mr. G. Henry Kinahan, G. S. I., read the following paper—

ON A REVERSED FAULT OCCURRING IN THE LEINSTER COAL-FIELD, AT THE JUNCTION OF THE QUEEN'S COUNTY AND COUNTY OF KILKENNY.

My friend, B. B. Edge, Esq., mentioned to me a remarkable fault in the Doonane Colliery, the last time I was in the Queen's County (May, 1859), which he had forgotten to point out when I was examining that district. At the time he mentioned it, he was unable to find his work-

ing plan; but since then he has forwarded me a copy, which I beg to lay before this Society.



a, coal, 9 ft. 6 in.; *b*, fire-clay; *c*, seat; *d*, bind, with beds of clay ironstone.
Scale, 80 feet to 1 inch.

This fault runs nearly N. and S., from the Queen's County into Kilkenny, as marked on the Government map (see sheet 137). It was proved in the workings on the "Old Colliery," or "Three-foot" coal, at Doonane, where it was found to be an upthrow to the west of 14 feet, and to 'hade' or underlie also to the west, as shown in Mr. Edge's section (see fig.), and therefore causes an overlap of the coal and other beds. The thickness of the coal at the east and west of the fault was 2 feet 9 inches, and it overlapped itself 17 feet.

During the working of the coal at the east of the fault in the Doonane Colliery, Queen's County, the coal brought up by the fault was also being worked in the Pullagh Colliery, county of Kilkenny.* The latter place being wet, the colliers sank an underground shaft down into the works of the Doonane Colliery, and flooded them. It then became the subject of a law-suit between the proprietors, the Hon. Mr. Wandesforde and Mr. Edge, and was tried at three consecutive assizes at Maryborough, commencing in the year 1854 or 1855. It was then decided in favour of the latter, and subsequently a large portion of the Pullagh Colliery was leased by the Hon. Mr. Wandesforde to Mr. Edge, who joined the works in the two collieries by a tunnel, as shown in the section. The tunnel was cut through that part of the fault which lies in the Queen's County, about 150 yards to the north of the boundary. I have mentioned all these particulars, as there is now no way of examining so remarkable a fault, the pits and workings being all closed.

I may here also observe that, since I examined this district, Captain Fitzmaurice, R. N., has proved a peculiar fault in his colliery at Coorlaghan. When I was there, they were sinking a vertical shaft at the N. W. of a fault that was supposed to be an upthrow to the N. W.: they have now proved that it is so; but the beds are so curiously crumpled and doubled up, that they cut the same coal either two or three times. I cannot myself vouch for the truth of the above state-

* This colliery is included in the Curragh Colliery in the explanation of sheet 137 of the Government Geological Map, and the coal that was worked in it is supposed to be the same as the one we call No. 3.

ment, not having seen it; but it must be an interesting case, and well worthy of an examination, which I hope to make at some future period.

Mr. B. B. Edge showed me a cabinet of fossils, collected by his son, John Edge, Esq., T. C. D., among which is a remarkable specimen of *Alethopteris lonchitoides*, with three *pinnules* joined to a *primary rachis*, which proves that the fern has a *bipinnate* frond.

Lord Talbot de Malahide gave the thanks of the Society to the President for his paper.

The Meeting then adjourned.

ANNUAL GENERAL MEETING, WEDNESDAY, FEBRUARY 8, 1860.

LORD TALBOT DE MALAHIDE, V. P., in the Chair.

The ballot having closed, the following gentlemen were declared duly elected:—

PRESIDENT.—Rev. Professor Haughton, F. R. S.

VICE-PRESIDENTS.—Sir Richard Griffith, Bart., LL. D.; Lord Talbot de Malahide; Robert Callwell, M. R. I. A.; Robert Mallet, F. R. S.; James Apjohn, M. D., F. R. S.

TREASURERS.—Gilbert Sanders, M. R. I. A.; F. J. Sidney, LL. D.

SECRETARIES.—Joseph Beete Jukes, F. R. S.; E. Perceval Wright, M. B., F. L. S.

COUNCIL.—Rev. H. Lloyd, D. D., F. R. S.; John Kelly, Esq.; Samuel Downing, LL. D.; John B. Doyle, Esq.; J. R. Kinahan, M. D., F. L. S.; G. V. Du Noyer, M. R. I. A.; Alexander Carte, M. B.; Edward Wright, LL. D.; Professor Harvey, M. D., F. R. S.; Robert H. Scott, M. A.; Samuel Gordon, M. D.; William H. Baily, F. G. S.; Major Leech, R. E.; Alphonse Gages, M. R. I. A.; R. S. Reeves, Esq.

The Society then adjourned till 8 o'clock.

ADJOURNED ANNIVERSARY MEETING.

The PRESIDENT in the Chair.

THE Minutes of the morning Meeting were read and confirmed, and the Report of Council read.

REPORT.

THE Council have to congratulate the Society that during the past year they have lost no members by death.

Some changes have, however, taken place, since eight Annual Members have left the Society. This loss of eight, however, from the list of our Annual Members has been more than compensated by the election of nine new Annual Members during the past year.

The numbers of our Honorary and Annual Members thus remain the same; while our Corresponding Members have been increased by three, and our Life Members by one, which brings the total number of the Society to 150.

The state of the Society's funds is also satisfactory, inasmuch as, after paying all liabilities for the year 1859, there is a balance to the credit of the Society amounting to £13 9*s.* 11*d.*, in addition to a sum of £80, which is invested in the Funds.

Satisfactory as this result may be deemed, it has, however, only been attained, and can only be conserved, by the exercise of the most rigid economy, even to an extent which, your Council cannot conceal from themselves, is calculated to be prejudicial to the interests and usefulness of the Society, since it will prevent their any longer illustrating their publications. It has lately been the practice for the Society to pay half the cost of the illustrations of the papers, the authors paying the other half. The permanent income of the Society, however, is barely equal to the expenses which are absolutely necessary, independently of this one; so that, for the future, the Society can only undertake to print the letterpress of the papers communicated to it, leaving the illustrations to be supplied by each author at his own discretion.

Your Council wish, therefore, to urge upon the attention of the Members, and the public at large, the desirableness of increasing the number of the subscribing Members. An increase of even twenty or thirty of these would enable your Council to add largely to the value of your Journal, which is now circulated among scientific societies all over the world, and of which each member of the Society receives a copy.

In the Appendix will be found the following tabular lists:—

1st. A list of all the Members now on the books of the Society.

2nd. A list of the names of Members gained and lost during the year 1859.

3rd. An abstract of the Treasurer's account for the year 1859.

4th. A list of the donations received during the past year.

5th. A list of the Societies and Institutions to whom a copy of the Journal of the Society is regularly forwarded.

The Report of the Council having been read, the following gentlemen were elected Ordinary Members of the Society:—1. Archibald M'Comas, 23, Rathmines-road; 2. R. Joy, 33, Mountjoy-square; and the following as Associate Members for the year 1859–60:—J. Glennon, Dolphin's-barn; J. M. Scott, Trinity College.

APPENDIX TO ANNUAL REPORT.

No. I.

LIST OF MEMBERS, CORRECTED TO JANUARY 31, 1860.

Members are requested to correct errors in this List, by letter to the Rev. Samuel Haughton, *Trinity College, Dublin.*

HONORARY MEMBERS.

Elected.
1844. 1. Boué, Amie, F. G. S., *Paris.*
1844. 2. Lyell, Sir Charles, F. R. S., 11, *Harley-street, London.*
1844. 3. Murchison, Sir Roderick I., F. R. S., 16, *Belgrave-square, London.*
1832. 4. Sedgwick, Rev. A., F. R. S., *Cambridge.*

HONORARY CORRESPONDING MEMBERS.

1854. 1. Thomas Oldham, F. R. S., *India.*
1854. 2. Arthur A. Jacob, C. E., *India.*
1855. 3. Joseph Medlicott, *India.*
1859. 4. John Gordon, C. E., *India.*
1859. 5. Henry J. B. Hargrave, C. E., *India.*
1859. 6. John Hime, *Pernambuco.*

MEMBERS WHO HAVE PAID LIFE COMPOSITION.

1853. 1. Allen, Richard Purdy, *Austin Friars, London.*
1857. 2. Carson, Rev. Joseph, D. D., F. T. C. D., *Trinity College.*
1832. 3. Davis, Charles, M. D., 33, *York-street.*
1857. 4. Greene, John Ball, 6, *Ely-place.*
1857. 5. Haliday, A. H., A. M., F. L. S., M. R. I. A., *Harcourt-street.*
1831. 6. Hamilton, Sir W. R., M. R. I. A., *Observatory, Dunsink.*
1848. 7. Haughton, Rev. Professor, F. R. S., 40, *Trinity College.*
1850. 8. Hone, Nathaniel, M. R. I. A., *St. Doulough's, Co. Dublin.*
1831. 9. Hutton, Robert, F. G. S., *Putney Park, London.*
1851. 10. Jukes, Joseph Beete, F. R. S., 51, *Stephen's-green.*
1834. 11. King, Hon. James, M. R. I. A., *Mitchelstown.*
1844. 12. King, John, *Dame-street.*
1856. 13. Lentaigne, John, M. D., *Great Denmark-street*
1848. 14. Luby, Rev. Thomas, D. D., F. T. C. D., *Trinity College.*
1851. 15. Malahide, Lord Talbot de, F. R. S., *Malahide Court, Malahide.*
1838. 16. Mallet, Robert, C. E., F. G. S., *Delville, Glasnevin,* and 11, *Bridge-street, Westminster, London, S. W.*
1846. 17. Murray, B. B., 69, *Lower Gardiner-street.*
1859. 18. Ogilby, William, *Liscleen, Dunmanagh, Co. Tyrone.*
1851. 19. Whitty, John Irvine, LL. D., *Henrietta-street.*

MEMBERS WHO HAVE PAID HALF LIFE COMPOSITION.

1831. 1. Baillie, Rev. James Kennedy, D. D., *Ardtrea, Stewartstown.*
1854. 2. Barnes, Edward, *Ballymurtagh, Co. Wicklow.*
1832. 3. Bryce, James, *High School, Glasgow.*
1855. 4. Carter, Sampson, C. E., *Kilkenny.*
1855. 5. Clarke, Edward, 3, *Frankfort Buildings, Rathgar.*
1854. 6. Clemes, John, *Luganure Mine, Glendalough, Co. Wicklow.*

Elected.
1857. 7. Crawford, Robert, C. E., *care of Messrs. Peto and Betts*, 9, *Great George's-street, Westminster.*
1856. 8. Du Noyer, G. V., M. R. I. A., 51, *Stephen's-green.*
1832. 9. Dunraven, Earl of, F. R. S., *Adare, Co. Limerick.*
1836. 10. Enniskillen, Earl of, M. R. I. A., *Florence Court, Enniskillen.*
1844. 11. Esmonde, Sir Thomas, Bart., M. R. I. A., 9, *Johnstown Castle, Wexford.*
1854. 12. Foote, Frederick J., 51, *Stephen's-green.*
1853. 13. Harkness, Professor, F. G. S., *Queen's College, Cork.*
1856. 14. Haughton, Lieut. John, R. A., *St. Helena.*
1857. 15. Haughton, John Hancock, Esq., *Carlow.*
1850. 16. Head, Henry, M. D., *Lower Fitzwilliam-street.*
1858. 17. Hill, J., C. E., *Tullamore.*
1840. 18. Jackson, James E., *Tulliderry, Blackwatertown.*
1839. 19. James, Colonel, R. E., F. R. S., *Ordnance Survey Office, Southampton.*
1858. 20. Jones, Rev. Henry Hampden, *Adare, Co. Limerick.*
1832. 21. Kearney, Thomas, *Pallasgreen, Co. Limerick.*
1857. 22. Keane, Marcus, *Beech Park, Ennis, Co. Clare.*
1835. 23. Kelly, John, 38, *Mountpleasant-square.*
1853. 24. Kinahan, George H., *St. Kilda, Sandycove, Dalkey.*
1839. 25. Lansdowne, Marquis of, 54, *Berkeley-square, London.*
1838. 26. Larcom, Major-General, R. E., LL. D., F. R. S., *Phœnix Park.*
1858. 27. Leech, Major, R. E., *Mountjoy Barracks, Phœnix Park.*
1840. 28. Lindsay, Henry L., C. E.
1832. 29. Mac Adam, James, F. G. S., 18, *College-street, East, Belfast.*
1840. 30. Montgomery, James E., M. R. I. A.
1856. 31. Molony, C. P., Capt., 25th Regt., Madras N. I., *per Messrs. Grindlay and Co.*, 63, *Cornhill, London.*
1856. 32. Medlicott, Henry, *Roarkee, Bombay.*
1857. 33. M'Ivor, Rev. James, *Rectory, Moyle, Newtownstewart, Co. Tyrone.*
1845. 34. Neville, John, C. E., M. R. I. A., *Dundalk.*
1852. 35. O'Kelly, Joseph, 61, *Stephen's-green.*
1844. 36. Palmerston, Viscount, G. C. B., M. P., 4, *Carlton Gardens, London.*
1832. 37. Portlock, Major-Gen., R. E., F. R. S., 58, *Queen's Gardens, Hyde Park.*
1832. 38. Renny, Henry L., R. E., *Canada.*
1854. 39. Smyth, W. W., *Jermyn-street, London.*
1832. 40. Tighe, Right Hon. William, *Woodstock, Innistiogue.*
1834. 41. Verschoyle, Archdeacon, *Rathbarron, Collooney.*
1853. 42. Webster, William B., 104, *Grafton-street.*
1846. 43. Wilson, Walter, 51, *Stephen's-green.*
1854. 44. Wyley, Andrew, 51, *Stephen's-green.*
1857. 45. Wynne, Arthur B., 51, *Stephen's-green.*

ANNUAL MEMBERS.

1831. 1. Apjohn, James, M. D., F. R. S., *South-hill House, Blackrock.*
1854. 2. Ashton, Samuel, *Woodfield, Newtownbarry.*
1857. 3. Baily, W. H., F. G. S., 51, *Stephen's-green.*
1857. 4. Bandon, Right Hon. Lord, *Castle Bernard, Co. Cork.*
1859. 5. Barker, John, M. D., 64, *Waterloo-road.*
1855. 6. Barton, H. M., 5, *Foster-place.*
1859. 7. Battersby, Francis, M. D., 16, *N. Cumberland-street.*
1844. 8. Bective, Earl of, *Headford, Kells.*
1858. 9. Bermingham, J., *Millbrook, Tuam.*
1831. 10. Brady, Right Hon. Maziere, Chancellor, 26, *Upper Pembroke-street.*
1857. 11. Bolton, George, Jun., 8, *Upper Ormond-quay.*
1840. 12. Callwell, Robert, M. R. I. A., 25, *Herbert-place.*
1857. 13. Carte, Alexander, A. M., M. B., *Royal Dublin Society.*
1858. 14. Cotton, Charles, *Mallow Railway Company, Mallow.*

Elected.
1857. 15. Craig, G. A., C. E., 6, *Ely-place.*
1834. 16. Croker, Charles P., M. D., 7, *Merrion-square, West.*
1846. 17. D'Arcy, Matthew, M. R. I. A., *Anchor Brewery, Usher-street.*
1849. 18. Downing, Samuel, C. E., LL. D., 6, *Trinity College.*
1832. 19. Dublin, The Archbishop of, *The Palace, Stephen's-green.*
1857. 20. Dowse, Richard, *Blessington-street.*
1852. 21. Doyle, J. B., *Martello-terrace, Sandymount.*
1853. 22. De Vesci, Lord, *Abbeyleix House, Abbeyleix.*
1857. 23. Farran, Charles, M. D., *Feltrim, Malahide.*
1856. 24. Fleming, Lionel J., C. E., 2, *Henrietta-street.*
1857. 25. Frith, R. J., C. E., *Leinster-road, Rathmines.*
1858. 26. Gages, Alphonse, M. R. I. A., 51, *Stephen's-green.*
1849. 27. Galbraith, Rev. Joseph A., F. T. C. D., *Trinity College.*
1856. 28. Ganley, Patrick, 6, *Ely-place.*
1849. 29. Gyles, A. M'Gwire, *Saunders' Court, Kyle, Enniscorthy.*
1831. 30. Griffith, Sir R., Bart., LL. D., 2, *Fitzwilliam-place.*
1852. 31. Gordon, Samuel, M. D., 11, *Hume-street.*
1856. 32. Good, John, *City-quay.*
1859. 33. Green, Murdock, 52, *Lower Sackville-street.*
1857. 34. Hampton, Thomas, C. E., 6, *Ely-place.*
1848. 35. Harvey, Professor, M. D., F. R. S., 40, *Trinity College.*
1834. 36. Hutton, Thomas, F. G. S., 116, *Summer-hill.*
1853. 37. Hemans, George W., C. E., 10, *Rutland-square, East.*
1852. 38. Jellett, Rev. Professor, F. T. C. D., M. R. I. A., 6, *Trinity College.*
1842. 39. Jennings, F. M., M. R. I. A., F. G. S., *Brown-street, Cork.*
1858. 40. Jones, William, C. E., 6, *Ely-place.*
1858. 41. Irwin, George W., C. E., 6, *Ely-place.*
1856. 42. Kinahan, J. R., M. D., M. R. I. A., F. L. S., *St. Kilda, Sandycove, Dalkey.*
1853. 43. Kingsmill, Thomas W., Jun., *Sidmonton, Bray.*
1831. 44. Lloyd, Rev. Humphrey, D. D., F. T. C. D., 35, *Trinity College.*
1854. 45. Longfield, Rev. George, F. T. C. D., *Trinity College.*
1855. 46. M'Causland, Dominick, 12, *Fitzgibbon-street.*
1831. 47. M'Donnell, John, M. D., 4, *Gardiner's-row.*
1852. 48. Mac Donnell, Rev. Richard, D. D., Provost of Trinity College, *Provost's House, Trinity College.*
1837. 49. Mollan, John, M. D., 8, *Fitzwilliam-square, North.*
1851. 50. M'Dowell, George, F. T. C. D., 6, *Trinity College.*
1849. 51. M'Guire, Thomas, 46, *Kildare-street.*
1859. 52. Moore, Joseph Scott, *The Manor, Kilbride, Co. Dublin.*
1831. 53. Nicholson, John, M. R. I. A., *Balrath House, Kells.*
1856. 54. O'Brien, Octavius, 23, *Kildare-street.*
1859. 55. O'Grady, M. T., 35, *Blessington-street.*
1857. 56. O'Meara, Rev. Eugene, A. M., 57, *Great Brunswick-street.*
1832. 57. Patten, John, *Royal Dublin Society.*
1843. 58. Petherick, John, *Knockmahon, Kilmacthomas.*
1857. 59. Phayre, George, C. E., 60, *Upper Dominick-street.*
1857. 60. Porter, William, C. E., 13, *Charlemont-mall.*
1857. 61. Reeves, R., 22, *Upper Mount-street.*
1856. 62. Robinson, Hartstong, 15, *St. James's-terrace, Malahide.*
1852. 63. Smith, Robert, M. D., 63, *Eccles-street.*
1852. 64. Sanders, Gilbert, M. R. I. A., 2, *Foster-place.*
1854. 65. Scott, Robert H., A. M., 13, *Suffolk-street.*
1849. 66. Sidney, F. J., LL. D. 19, *Herbert-street.*
1857. 67. Stack, Rev. Thomas, F. T. C. D., *Trinity College.*
1859. 68. Stokes, William, M. D., *Merrion-square.*
1857. 69. Tait, Alexander, C. E., *Santry.*
1859. 70. Waldron, L., M. P., LL. D., *Ballybrack, Dalkey.*

1859. 71. Walker, William T., 2, *Trinity College.*
1832. 72. Wall, Rev. C. W., D. D., Vice-Provost, *Trinity College.*
1857. 73. Welland, W. T., 48, *Upper Rutland-street.*
1859. 74. Wilde, W. R., M. D., *Merrion-square.*
1851. 75. Wright, Edward, LL. D., M. R. I. A., *Floraville, Donnybrook.*
1853. 76. Wright, E. Perceval, M. B., M. R. I. A., F. L. S., *Museum, Trinity College.*

ASSOCIATES FOR THE YEAR 1859-60.

1. Bateman, C. W., 56, *Camden-street.*
2. Brownrigg, W. B., *Adelaide-road.*
3. Cook, S., 20, *Pleasant-street.*
4. Crawford, W., 17, *Trinity College.*
5. Denny, R., 32, *Hardwicke-street.*
6. Duke, R. A., 21, *Rathmines.*
7. Dopping, C., 64, *Lower Mount-street.*
8. Geoghegan, H., 4, *Upper Merrion-street.*
9. Gibbon, J., *Cottage, Sandymount.*
10. Glennon, J. *Dolphin's-barn.*
11. Hunt, S., 34, *Frederick-street.*
12. M'Grorty, J., 10, *St. Andrew-street.*
13. Patterson, B. T., 1, *Sandford-place, Sandford.*
14. Robertson, R., *Gledswood, Roebuck.*
15. Symes, H. A., *Sussex-parade, Kingstown.*
16. Tudor, R. P., 12, *Fitzwilliam-street.*
17. Townsend, H., 17, *Trinity College.*

No. II.

MEMBERS GAINED.

Corresponding Members.

*1. Gordon, J., C. E., *India.*
2. Hargrave, Henry J. B., C. E., *India.*
3. Hime, John, *Pernambuco.*

Annual Members.

1. Barker, John, M. D., 64, *Waterloo-road.*
2. Battersby, Francis, M.D., 16, *North Cumberland-street.*
3. Green, Murdock, 52, *Lower Sackville-street.*
4. Moore, J. Scott, *The Manor, Kilbride.*
5. O'Grady, M. T., 35, *Blessington-street.*
6. Stokes, W., M. D., *Merrion-square, North.*
7. Waldron, L., M. P., *Ballybrack, Dalkey.*
8. Walker, W. T., 2, *Trinity College.*
9. Wilde, W. R., M. D., 1, *Merrion-square, North.*

MEMBERS LOST.

Resigned.

1. Gordon, John, C. E., *Dominick-street.*
2. Locke, John, 14, *Henrietta-street.*
3. Pigot, Right Hon. Chief Baron, 52, *Stephen's-green, North.*

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* This gentleman was previously an Annual Member.

Subscriptions in Arrear.

1. Byrne, Griffin, C. E., *Lower Mount-street.*
2. Byrne, Patrick, 27, *Talbot-street.*
3. Hamilton, C. W., 40, *Dominick-street.*
4. Kavanagh, J. W., *Apsley House, Rathmines.*
5. Kincaid, J., 3, *Herbert-street.*

The numbers in the several classes of Members now stand as follows:—

	Commencement of 1859.	Commencement of 1860.
Honorary Members,	4	4
Corresponding ditto,	3	6
Life ditto,	63	64
Annual ditto,	76	76
	146	150

No. III.

ABSTRACT OF TREASURER'S ACCOUNT FOR THE YEAR ENDED DECEMBER 31, 1859.

Dr.

1859.				£	s.	d.
To Balance from last year's Account,				16	4	9
— Amount of Subscriptions received for year ending this date:—						
— Life Composition,	£10	0	0			
— Half-life Composition,	15	0	0			
— Admission Fees,	4	0	0			
— Annual Subscriptions,	67	10	0			
				96	10	0
— Amount of Dividend received on Government Stock,				2	8	8
— Received from Professor Kinahan, M. D., being half-cost of Illustrations refunded,				1	17	6
				£117	0	11

Cr.

1859.				£	s.	d.
By Editors of "Natural History Review," to June 30, 1859 (per Draft 10,299),				15	0	0
— Assistant Secretary's half-year's Salary, to June 30, (per Draft 10,300),				10	0	0
— Editors of "Natural History Review," to Dec. 31, (per Draft 526),				15	0	0
— Sundries, per Assistant Secretary, (per Draft 527),	6	6	0			
— Gratuity to Attendant,	1	10	0			
— Carriage of Books,	2	10	2			
— Illustrations for Vol. VIII., Part 2,	2	17	6			
— Porter's Wages,	7	10	0			
				20	13	8
— For Illustrations to Vol. VIII., Part 2, of Society's Journal (per Draft 528),				18	10	0
— Mr. Gill, for Printing for one year, (per Draft 529),				6	13	3
— Sundries, per Assistant Secretary,	3	3	3			
— Mr. Tallon's Account for Stationery,	1	5	4			
— Carriage of Books,	2	0	6			
— Porter's Wages,	6	5	0			
				12	14	1
— Assistant Secretary, Salary to December 31, 1859, (per Draft 531),				10	0	0
				£108	11	0
— Balance in Bank,	£8	9	11			
— Cash in hands,	5	0	0			
				13	9	11
				£117	0	11

Jan. 2, 1860.

GILBERT SANDERS, *Treasurer.*

No. IV.

DONATIONS RECEIVED DURING THE YEAR ENDING 31 DECEMBER, 1859.

Journal of the Proceedings of the Linnæan Society, Vol. III., Nos. 11 to 15. Presented by the Society.

Ditto, Supplement to Botany, Nos. 1 and 2. Presented by the Society.

Proceedings of the Geographical Society, London, Vol. III., Nos. 1 to 6. Presented by the Society.

Journal of the Royal Geographical Society, No. 28. Presented by the Society.

Report of the Proceedings of the Geological and Polytechnic Society, West Riding of Yorkshire, 1857–58, 1858–59. Presented by the Society.

Proceedings of the Royal Society, Vol. IX., Nos. 33 to 36. Presented by the Rev. Professor Haughton, F. T. C. D.

Transactions of the Historic Society of Lancashire and Cheshire, Vol. X. Presented by the Society.

Memoirs of the Literary and Philosophical Society of Manchester, 1st Series, Vol. IV.; Part 1, Vol. V.; 2nd Series, Vols. XI., XII. Presented by the Society.

Proceedings of the Kilkenny and South-East of Ireland Archæological Society, Vol. II., Parts 17 to 22. Presented by the Society.

Quarterly Journal of the Geological Society of London, Vol. XV., Nos. 57 to 59. Presented by the Society.

Dublin University Zoological and Botanical Association, Vol. I., Part 2; with list of Members and Rules of Society. Presented by the Society.

Proceedings of the Literary and Philosophical Society of Liverpool, No. 13. Presented by the Society.

Transactions of the Royal Scottish Society of Arts, Vol. V., Part 2. Presented by the Society.

Proceedings of the Philosophical Society of Glasgow, Vol. V., Part 1. Presented by the Society.

Proceedings of the Zoological Society of London, Parts 1 and 2. Presented by the Society.

Proceedings of the Royal Institution of Great Britain, 1858–59, No. 9. Presented by the Institute.

Bulletin des Séances de la Société Vaudoise des Sciences Naturelles, Vol. V. Presented by the Society.

Catalogue de la Bibliotheque de la Societé Vaudoise des Sciences Naturelles. Presented by the Society.

Jahrbuch der K. K. Geologischen Reichsanstalt Vienna, Vol. IX., Nos. 1 to 4. Presented by the Society.

Bulletin de la Societe Paleontologique de Belgique, Vol. I. Presented by the Society.

Zeitschrift für Allgemeine Erdkunde, Berlin, Nos. 67 to 75. Presented by the Society.

Zeitschrift für die Gesammten Naturwissenschaften, Berlin, 1858, Nos. 7 and 8. Presented by the Society.

The American Journal of Science and Art, Nos. 79 to 83. Presented by the Editors.

Transactions of the Academy of Sciences of St. Louis, Vol. I., Part 2. Presented by the Academy.

Journal of the Boston Natural History Society, Vol. VI., No. 4. Presented by the Society.

Proceedings of the Boston Natural History Society, Vol. VI., Nos. 11 to 22. Presented by the Society.

Proceedings of the Academy of Natural Science of Philadelphia, pp. 127 to 273. Presented by the Society.

Journal of the American and Statistical Society, Nos. 1 to 3. Presented by the Society.

The Canadian Journal of Industry, Science, and Art, Nos. 18 to 23. Presented by T. Henning, Esq., Toronto.

Sensorial Vision: a paper read before the Leeds Philosophical and Literary Society. By Sir J. F. W. Herschel, Bart. Presented by the Author.

China and its Trade. By T. Crawford, Esq., F. R. S. Presented by the Author.

Terrestrial Climate, as influenced by the distribution of land and water at different geological epochs. By H. Hennessy, F. R. S. Presented by the Author.

Articles published in the "Edinburgh Review," 1817, 1849. By W. H. Fitton, M. D. Presented by the Author.

Historical Account of the Invertebrata occurring in the Permian rocks of the North of England. By Professor Wm. King. Presented by the Author.

A New System of Chemical Philosophy, Part 1, and Vol. XI., Part 1. By J. Dalton, Esq., LL. D. Presented by the Literary and Philosophical Society of Manchester.

Meteorological Observations and Essays. By J. Dalton, Esq., LL. D. Presented by the Literary and Philosophical Society of Manchester.

Address delivered at the Anniversary Meeting of the Geological Society, London. By Major-General Portlock, R. E., President. Presented by the Author.

The Rocks of Kansas, with description of new Permian Fossils. By G. C. Swallow and F. Huron. Presented by the Authors.

Description of new Fossils from the Coal Measures of Missouri and Kansas. By B. F. Shumond and G. C. Swallow. Presented by the Authors.

First and Second Annual Reports of the Geological Survey of Missouri. By G. C. Swallow, State Geologist. Presented by the Author.

Report of the Superintendent of the United States Coast Survey for the year 1856. By Professor A. D. Bache, Superintendent U. S. Coast Survey. Presented by the Author.

Geological Explorations in Kansas Territory. By T. B. Meek and F. V. Hayden. Presented by the Academy of Natural Sciences, Philadelphia.

Conservatory Journal, Boston, Nos. 1 to 4. Presented by the Editors.

Memoirs of the Geological Survey of India, Vol. I., Parts 1 and 2. Presented by Thos. Oldham, Superintendent of Geological Survey of India.

Essay on Comparative Petrology. By M. J. Durocher, Mining Engineer and Professor of the Faculty of Sciences at Rennes. Translated from the Annales des Mines, Vol. IX., 1857, by Rev. Samuel Haughton, M. A., F. T. C. D., and Professor of Geology, T. C. D. Presented by the Translator.

Annual Reports of the Leeds Philosophical and Literary Society, 1857-8, 1858-9. Presented by the Society.

On the Lower Palæozoic Rocks of the S. E. of Ireland, and their associated Igneous Rocks. By J. Beete Jukes, M. A., F. R. S., Local Director of Geological Survey, Ireland, and Rev. Samuel Haughton, M. A. F. T. C. D., and Professor of Geology, T. C. D. Presented by the Authors.

On the structure of Lavas which have consolidated on steep slopes; with remarks on the mode of origin of Mount Ætna, and on the theory of Craters of elevation. By Sir C. Lyell, F. R. S. Presented by the Author.

Annual Report of the Superintendent of the Geological Survey of India, 1858-9. Presented by Thos. Oldham, Esq., Superintendent.

Annual Reports and Transactions of the Plymouth Institute, and Devon and Cornwall Natural History Society, 1857-9. Presented by the Society.

Report of the British Association for the Advancement of Science, Leeds, 1858. Presented by the Association.

Sur le Neocomien dans le Jura et son role dans le Serie Stratigraphique. Par Professor Jules Marcou. Presented by the Author.

Dyas et Trias ou le Nouveau Gres Rouge en Europe dans l'Amerique die Nord et dans l'Indie. Par Professor Jules Marcou. Presented by the Author.

Reply to the Criticisms of James D. Dana. By Professor Jules Marcou. Presented by the Author.

On the Geology of the South Staffordshire Coal-fields. By J. Beete Jukes, M. A. Presented by the Author.

Annual Report of the Director-General of the Geological Survey of the United Kingdom. Presented by Sir R. Murchison, Director-General.

Address delivered at the Annual Meeting of the Royal Geographical Society, May, 1859. By Sir R. Murchison, President. Presented by the Author.

Annual Report of the Smithsonian Institute, 1857. Presented by the Institute.

Defence of Dr. Gould. By the Scientific Council of the Dudley Observatory, Albany. Presented by the Council.

Reply to the Statement of the Trustees of the Dudley Observatory. By B. A. Gould. Presented by the Author.

Geological Sketch of the estuary and fresh-water deposit forming the bad lands of Judith River. By F. V. Hayden, M. D. Presented by the Author.

Extinct Vertebrata from the Judith River, and great Lignite formations of Nebraska. By J. Leidy, M. D. Presented by the Author.

Observations on the Genus Unio. By Isaac Lea, LL. D., President of the Academy of Natural Sciences of Philadelphia. Presented by the Author.

Transactions of the Philosophical Institute of Victoria, Vol. III. Presented by the Institute.

Twenty-seven Quarto Sheets of the Geological Map of Ireland, viz., Nos. 110, 111, 112, 128, 140, 141, 142, 150, 151, 155, 160, 161, 162, 163, 164, 171, 172, 173, 174, 175, 182, 183, 184, 185, 190, 197, 198, and books of data. Presented by Sir R. Murchison, Director-General, Geological Survey of Great Britain.

Map of Chicago Harbour and Bar, Illinois, U. S. A. Presented by Lieutenant-Colonel Graham.

No. V.

SOCIETIES AND INSTITUTIONS ENTITLED TO RECEIVE THE JOURNAL OF THE GEOLOGICAL SOCIETY OF DUBLIN.

ABERDEEN, .	University Library.
ALBANY, . .	State Library, New York.
AMSTERDAM, .	Royal Academy of Sciences.
BELFAST, . .	Queen's College Library.
BERLIN, . .	Royal Academy of Sciences.
	German Geological Society, per Besser'sche Buchhandlung, *Behren-str.*, 7, *Berlin*.
BORDEAUX, .	Imperial Academy of Sciences.
BOSTON, . .	American Academy.
	Natural History Society.
BRISTOL, . .	Institution for the Advancement of Science, Literature, and the Arts.
BRUSSELS, .	Academy of Sciences.
CALCUTTA, .	Public Library.
CAMBRIDGE, .	Philosophical Society.
	University Library.
COPENHAGEN,	Royal Society of Science.
CORK, . . .	Queen's College Library.
	Royal Institution.
CORNWALL, .	Royal Polytechnic Institution.
DIJON, . . .	Academy of Sciences.
DUBLIN, . .	Royal College of Surgeons Library.
	Royal Irish Academy.
	University Library.
	Royal Dublin Society.
	Natural History Society.
	Ordnance Survey Library.
	Geological Survey of Ireland.
	University Philosophical Society.
	University Zoological and Botanical Association.
EDINBURGH, .	Royal Society.
	Wernerian Society.
	Society of Arts.
	University Library.

FLORENCE, .	Society of Physics and Natural History.
GALWAY, . .	Queen's College Library.
GENOA, . .	Society of Physics.
GLASGOW, .	University.
GOTTINGEN, .	University.
HANOVER, .	Royal Library.
KILKENNY, .	Archæological Society.
LAUSANNE, .	Société Vaudoise des Sc. Nat.
LEEDS, . .	Geological and Polytechnic Society of the West Riding of Yorkshire.
	Philosophical and Literary Society.
LEIPSIG, . .	Royal Academy of Sciences (Saxony).
	University.
LIVERPOOL, .	The Literary and Philosophical Society.
	Historic Society of Lancashire and Cheshire.
LONDON, . .	Geological Survey, *Jermyn-street.*
	British Museum.
	Society of Arts, *John-street, Adelphi.*
	Royal Institution, *Albemarle-street.*
	Royal Society, *Burlington House.*
	Geological Society, *Somerset House.*
	Linnean Society, *Burlington House.*
	Geographical Society, 15, *Whitehall-place.*
	Civil Engineers' Institute, 25, *Great George's-street, Westminster.*
	Royal Asiatic Society, 5, *New Burlington-street.*
	Royal College of Surgeons.
	Zoological Society, 11, *Hanover-square.*
	Athenæum, 14, *Wellington-street, Strand, W. E.*
	Literary Gazette.
	The Hon. the East India Company, *East India House.*
LYONS, . . .	La Société Imperiale d'Agriculture, d'Histoire Naturelle, et des Arts Utiles.
	Société Linneen de.
	Academie Imperiale de.
MANCHESTER,	Literary and Philosophical Society of. [Sec., R. C. Christie.]
	Geological Society.
MELBOURNE, .	Philosophical Institute of Victoria.
MILAN, . .	Imperial Institute of Science.
MISSOURI, .	State Survey and University, *Geological Rooms, Columbia, U. S. A.*
MODENA, . .	Imperial Institute of Science.
MUNICH, . .	Royal Academy of Science.
NEW YORK, .	The Editors of Silliman's Journal of Science and Art.
OXFORD, . .	Bodleian Library.
	Ashmolean Society.
PARIS, . . .	Ecole Polytechnique.
	Geological Society.
	L'Ecole Imp. des Mines.
	Institute of France.
	Bibliotheque Imp.
	Jardin des Plantes Bibliotheque.
PHILADELPHIA,	American Philosophical Society.
	Natural History Society.
PLYMOUTH, .	Plymouth Institution and Devon and Cornwall Natural History Society.
QUEBEC, . .	Literary and Historical Society.
ROUEN, . .	Academy of Science.
ROME, . . .	The Vatican Library.
ST. ANDREW'S,	University Library.
ST. PETERSBURG,	Imperial Academy.
	Central Physical Observatory of Russia.
STOCKHOLM, .	Royal Academy of Science.

Strasbourg,	Société des Sciences Naturelles de.
Toronto, C. W.,	Canadian Institute, per Thomas Henning, Esq. University College.
Toulouse, .	Academy of Sciences.
Turin, . . .	Royal Academy.
Upsala, . .	Royal Society of Sciences.
Vienna, . .	Imperial Academy of Sciences.
	W. Haidinger, of Vienna, as Editor of the "Jahrbuch der K. K. Geologischen Reichsanstalt."
Washington,	Smithsonian Institute Library, per Henry Stevens, Esq., *Morley's Hotel, Trafalgar-square, London.*
Zurich, . .	Universitäts Bibliothek.

The President then proceeded to deliver the following

ADDRESS.

Gentlemen,—From the Report of Council just read, you will observe that we have lost eight Members, and gained nine, during the past year; and have also added to our list three new corresponding Members, so that the total number of Members, life and annual, on our books is now 150.

We have reason to feel grateful to the Giver of all good things, that we have not had to deplore the loss of any of our fellow-labourers during the year, by the hand of death.

In conformity with custom, I shall now invite your attention briefly to the progress made by Irish Geology during the past year, and then notice some of the most important additions to our science made elsewhere.

Progress of Irish Geology.

I. *Descriptive Geology and Palæontology.*

In Descriptive Geology, the Geological Society of Dublin has not recorded much progress—a circumstance which is to be accounted for by the fact that our contributions to this branch of the science are mostly confined to this country, and that, since the establishment of the Government Survey, the zeal and enterprise of private explorers have found other channels for their exercise. Our additions in this branch are limited to four, viz.:—

1. On isolated patches of the lower Coal-measure shales in the north part of the county of Dublin, by Mr. J. Beete Jukes, Director of the Irish Survey.
2. On an additional Permian locality in the county of Tyrone, by Sir Richard Griffith.
3. Geological map and section of the Vale of Ovoca, by Messrs. Egan and Geoghegan.
4. Geological section of the Peninsula of Hook, county of Wexford, by Messrs. Geoghegan and Patterson.

In the first of these papers Mr. Jukes expresses the opinion that the earthy black shaly limestones of the districts examined by him in the county of Dublin belong to the shale beds of the lower coal-measures, such as they are developed in the Kilkenny, Tipperary, and Cork coal-fields, and do not belong to the calp limestone, or middle portion of the carboniferous limestone of Ireland, to which they have been hitherto referred by Sir Richard Griffith and other geologists.

Mr. Jukes thus describes the similarity in lithological appearance of the shaly limestone beds of Westown, near the Naul, county of Dublin, to that of the lower coal-measure shales of the south of Ireland, and feels strongly disposed to rank them with those beds, unless good evidence to the contrary be adduced.

"Mr. Dunoyer and I were engaged in endeavouring to solve this problem in the early part of this year, and had formed one or two hypotheses to account for the facts, which we proposed to lay before the last meeting of the Society. The week before the meeting, however, he took me to a small quarry at the top of the hill of Westown, a little south of the Naul. It so happened that I had been, the preceding week, in the Queen's County and Kilkenny, examining the lower coal-measure shales of that district, and, therefore, had their peculiar lithological characteristics fresh in my eye, and I was instantly struck with the similarity of these black shales at Westown to those I had recently been observing to the southward. These shales are black, hard, and splintery, and lie in regular layers of one or two inches thick, so as to have a peculiarly 'banded' appearance when viewed *en masse*. They are generally iron-stained when weathered. Their peculiar character is constant over the northern part of the county of Cork, in the counties of Kerry, Limerick, Tipperary, Kilkenny, Queen's County, and Carlow. Their appearance in a cutting or quarry is very distinct from that of any shales interstratified with the limestone that I have seen; and in the counties just mentioned, where coal-measure shales occur, no one familiar with those shales would do otherwise than class those seen at Westown as coal-measure shales, unless good evidence could be shown to the contrary."

Sir Richard Griffith, however, appears disposed still to maintain that the shale beds of Dublin belong to the calp formation, and not to the coal-measures, and we may expect a fuller statement of his reasons for this opinion during the coming year. At the conclusion of his paper, Mr. Jukes gives an interesting sketch of what he supposes the physical circumstances were, under which these shaly limestone beds were formed, in which he states his opinion that the wearing of the dark Cambro-Silurian rocks of the neighbourhood contributed the black argillaceous mud, the addition of which to the limestone formed the shale beds in question. The occurrence of iron pyrites diffused through this shale, would, however, as M. Gages has remarked, seem to point to a different cause for the black colour which characterizes it, as it may be evidence of the presence of organic matter decomposing the sulphates present, the carbon of which organic matter will contribute much to give the black colour to the shale or limestone in which it is found. There can

be little doubt, however, but that Mr. Jukes is, in the main, right in seeking for some distinct source of argillaceous matter, which was probably the Cambro-Silurian rocks of the adjoining country, although the source of the colour of the beds may be quite different.

The peculiar group of fossils that is found in these dark shale beds, whether high or low in the carboniferous limestone, and the association with them of plant remains, has led me to believe that they are of estuary origin: however,—" non nostri est tantas componere lites."

Sir Richard Griffith's paper on a new Permian locality at Templereagh, in the county of Tyrone, adds another outlier of magnesian limestone to the few already known to exist in Ireland, and renders probable its former much greater extension in the north of this country.

The two papers communicated by Messrs. Egan and Geoghegan, and by the latter gentleman and Mr. Patterson, though they do not add any new fact to our previous stock, are yet of value as careful records of observations of the rocks of two of the most interesting districts in Ireland, the Vale of Ovoca, celebrated for its mining wealth, and the peninsula of Hook, where a better section of the lower carboniferous limestone and its relation to the old red conglomerate is to be found, than in any other part of Ireland.

The Royal Irish Academy has published a paper on the Geology and Mineralogy of the South-east of Ireland, the geology of which is contributed by Mr. Jukes, and the mineralogy by myself. Mr. Jukes classifies the stratified rocks of this part of Ireland under the terms Cambrian and Cambro-Silurian; the latter terms appear to me to be very well chosen, inasmuch as it suggests the age of the formation as intermediate between the Cambrian and Silurian rocks, and leaves the precise determination of its position an open question, to be determined by future discoveries of its fossil contents.

In the same volume of the Irish Academy Transactions is also published a paper by Dr. Kinahan, on the Zoological Affinities of the most remarkable of the Cambrian fossils of Bray Head; a subject to which Dr. Kinahan has devoted much attention, and which he has elaborated with his usual skill.

The appearance of these geological papers in the Transactions of our Irish Academy is important, as it shows that the Academy, from which our own Society is an offshoot, still retains an interest in the science which we cultivate.

Some valuable additions have been made to Stratigraphic Geology by the Government Survey, not only by the publication of maps, but also by the excellent descriptions which now accompany each quarter-sheet. It is much to be regretted that these descriptions are little known, and that they are published in so scattered and fugitive a form that none but enthusiasts are ever likely to collect and bind them into volumes. Among those published in 1858, one of the most interesting is that intended to accompany quarter-sheet 45, S. E., containing a description of the classic locality of Ballyporeen. In this sheet of data,

some interesting diagrams of the effect of cleavage upon the shape of flint nodules in limestone, and of the conjugate systems of dip and strike joints, are given. From one of the figures, it would appear that the nodules of flint are flattened out in the planes of cleavage, so as to produce in a section on the plane of dip the appearance of elongation in the direction of the dip of cleavage, which has deceived many skilful observers. A similar appearance is shown in data 165, p. 21, in the cleavage of the anticlinal limestones near Mitchelstown, in which case, at both sides of the axis, the nodules are flattened out in the planes of cleavage. Such phenomena are easily explicable on the mechanical theory of cleavage, on the supposition that the flint nodules were soft when the cleavage took place, in which case we must suppose, as is highly probable, that they were originally deposited in the condition of gelatinous silex. In data 137, which is recently published, some highly interesting information is given of the Leinster coal-field, illustrated by some cases of remarkable faults and troubles in the coal.

Of the one-inch Geological Maps of Ireland, 73 sheets are already published, accompanied by 12 of the explanations and data to which I have alluded, and one sheet of vertical sections. The maps of the county of Dublin and neighbourhood have been lately brought out, and will be followed immediately by the highly interesting Carboniferous Trappean district in the neighbourhood of Limerick, a locality which attracted the attention of Dr. Apjohn and Sir Richard Griffith, in the earlier days of our Society.

In Palæontology, some additions have been made to our Irish lists during the past year.

Mr. Baily has described in our Journal a new species of Carboniferous Chiton, which he has named *Chiton Thomondiensis;* this species is of great size, and a restoration of it has been figured by Mr. Baily.

Our Member, Rev. Hamilton Jones, has also added a rare Echinoderm, totally different from any previously described, from the Carboniferous limestone of Adare, county of Limerick, a locality which has proved exceedingly rich in good and rare specimens. I have named it *Pentephyllum Adarense*, and figured it in our Journal. In the coal-measures of Lugacurren, near Athy, in the Queen's County, a locality has been found abounding in fossil beach tracks. I believe I am correct in stating that attention was first directed to it by my brother, Mr. Frederick Haughton, who resides in that neighbourhood. Four Plates illustrative of these fossils are published in our Journal, and Mr. Baily has also illustrated them by two woodcuts in "Explanations," No. 128. These fossils bear a striking resemblance to some found in rocks of similar age in the coal-measure flagstones of Northumberland, figured by Mr. Albany Hancock in the "Annals and Magazine of Natural History," 3rd Series, vol. ii. I feel disposed to agree with Mr. Hancock that such tracks are as likely to have been formed by crustaceans as by any other creatures, and think the remarkable and regular punctures which are found only at Lugacurren may probably be due to some projection of the tail, such as a Trilobite is furnished with. In the "Explanations,"

No. 137, Mr. Baily has made some important additions to our knowledge of the fossil contents of the Leinster coal shale beds. Among those described by Mr. Baily are the remarkable Trilobites, *Bellinurus regina* and *B. arcuatus*, to which I referred in my last Address. Also a number of new ferns, the names only of which can be here given—

Pecopteris Edgeii.
Sphenopteris pulchra.
Adiantites Kinahani.

The "Journal of the Royal Dublin Society" for 1859 contains some additions to the fossils of the Carboniferous limestone of Ireland, and also the "Proceedings of the Dublin Natural History Society," including some rare and some new Univalves and Cephalopoda, from Cork and Clonmel, found by Mr. Joseph Wright, of Cork, who has also published, in the "Proceedings of the Natural History Society of Dublin," a valuable local list of Carboniferous fossils. The new Irish fossils described and figured in these several publications have been named—

Cerithioides telescopium.
Orthoceras Clonmeliense.
O. Wrightii.
Nautilus Willockii.

The Royal Dublin Society has also published and illustrated a highly interesting description of Crimean fossils by Mr. Baily. The collection of fossils described is preserved in the Museum of the Society, and was formed chiefly by Dr. William Carte and Dr. Thornton.

The most important fact in Irish geology placed on record during the past year, is the discovery of a bone cave in the limestone at Dungarvan by Mr. Brennan, of that town, who has presented the bones found by him to the Royal Dublin Society, and published an account of their discovery in the Journal of that Society. Dr. Alexander Carte has examined and published a full account of these fossil bones, which he refers without hesitation to the following species :—

Euelephas primigenius (Mammoth).
Ursus spelæus (Great Cave Bear).
Ursus arctos (Fen Bear).
Equus, sp. n.
Cervus tarandus (Reindeer).

Together with portions of a hare, and of an unknown bird.

The geological interest of this discovery is unquestionable, and its value is much increased by the careful determination of the bones made by Dr. Carte.

On a review of the whole year, I think that we may congratulate ourselves on the progress of Irish geology, which has seldom been cultivated with more success, or by a greater number of observers.

The partial union of scientific results of the various learned Societies of Dublin, including the Royal Irish Academy and Royal Dublin

Society, with other minor Societies, has been in some degree due to their having adopted, in the "Natural History Review and Quarterly Journal of Science," a common channel of publication.

The result has been, in 1859, the issuing of 541 octavo pages, illustrated by 41 lithograph plates, by five Scientific Societies of Dublin; and there can be no doubt but that the extensive circulation thus secured abroad and at home for our labours, will tend greatly to increase the reputation of the Dublin School of Science, and, by a reflex action, encourage us to further exertions in our respective departments of Science. A still closer union between the Scientific Societies of Dublin is highly desirable, as there can be but little question as to the propriety of concentrating our energies on the maintenance of two or more Societies in this city, which might worthily represent the mental activity which undoubtedly exists amongst us.

In my opinion, we have carried the division of labour too far; and, although we have gained the advantages of that division, we are all, more or less, suffering from the deficiency of funds which is the necessary result of such a cause.

II.—Physical Geology and Mineralogy.

In this branch of geology, we have had four papers read before us during the past year, viz.:

1. "On Electric Calamine at Silvermines, county of Tipperary." By Dr. Apjohn.
2. "On the Felspar and Mica of the Granite of Canton." By the President.
3. "On so-called Serpentines from the Cape of Good Hope." By M. A. Gages.
4. "On Vivianite." By M. A. Gages.

In the first of these papers Dr. Apjohn has established the existence, in large quantity, of the zinc ore known as Electric Calamine, on the property of the General Mining Company of Ireland, at Silvermines, county of Tipperary. Dr. Apjohn suggests the propriety of smelting this ore, which is well known to be an hydrated silicate of zinc, with some powerful base, such as lime—an obvious modification of the usual process of smelting with charcoal only, which does not yet appear to have been adopted on a large scale in any country where this ore abounds.

In my own paper, on the Mica and Felspar of the Granite of Canton, I have shown that the felspar is Orthoclase, and have established the identity of the black mica with that of Leinster and Donegal in Ireland, and with the Lepidomelane of Russia described by Soltman.

In this paper I have expressed the opinion that the primary granites which form the lower basis of the crust of our globe are all formed, *probably*, of the same chemical, and *possibly*, of the same mineralogical constituents; and that the differences which we find in the felspars and

micas are accidental deviations from central types or forms, round which they naturally group themselves.

This abstract or theoretical black mica probably exists only as an idea or conception in our minds, and may not have a concrete development in any place; but it must be regarded as an essential constituent of the original granite formed in the astronomical epoch by the cooling of our globe. All our researches tend to prove that there is an original or type granite, characteristic of the azoic epoch of the earth's history, marked mineralogically by the presence of four important minerals:

1. Quartz;
2. Orthoclase felspar;
3. Black mica;
4. White mica;

and marked chemically by the abundance of potash, and the absence of lime.

In the paper published in the Transactions of the Royal Irish Academy, I have succeeded in determining the actual proportions in which the four just mentioned minerals occur in the granite of Leinster, viz.:

Quartz, ...	27·66	℔ cent.
Tersilicated felspar, . . .	52·94	,,
White mica (Margarodite), .	14·18	,,
Black mica, ...	5·27	,,
	100·05	

M. Gages has contributed to our Journal two papers, of which I have already given the titles. In the first of these he has examined the chemical composition of some so-called Serpentines from the Cape of Good Hope. It turns out, on careful examination, that they are not Serpentines at all, but hydrated silicates of alumina, deriving their serpentine colour from the presence of some silicate of iron, and their unctuous feel from the water that enters into their composition.

This view of M. Gages is evidently correct, from an inspection of their composition.

Silica, ...	58·11
Alumina, ...	26·10
Peroxide of iron, . . .	8·59
Water, ...	2·67

These rocks are referred by M. Gages to the class of indurated unctuous clays, such as Agalmatolite, Pagodite, &c., to which they clearly belong; and I may add, that this investigation furnishes one more fact in support of the opinion that the unaided eye and touch are as fallacious guides to the geologist as they would be to the engineer, and always require their first rude impressions to be corrected by the exacter methods of physical research.

I may here mention that, as soon as I had read M. Gages' paper, I was reminded of one, read by myself before this Society in 1854, on the Lead Mines of Luganure, in which I proved that a certain so-called Steatite contained little or no magnesia, and was in fact an indurated, hydrated clay, formed from the decomposition of the felspar and mica of the granite of the district. Its composition is like that of the mineral substance described by Mr. Gages:—

Silica, ...	50·00
Alumina, . . .	33·93
Water, ...	4·79
Potash, ...	7·17

Substances of this description are really not minerals at all, but may be regarded as hydro-metamorphic rocks.

In his paper on Vivianite, M. Gages has discussed the various theories proposed to account for the blue colour of the proto-phosphate of iron, often found in the interior of fossil bones, of recent date, and under similar conditions, indicating a deoxidating agency. He rejects the explanation founded on the supposed presence of a sesquiphosphate, and also that founded on the hydration of the proto-phosphate—inclining to the idea that the colour is due to some allotropic condition of the mineral, or, like the violet tint, developed in glass, in the decolorization of which too much manganese has been employed. This I believe to be a correct explanation of the colour, which appears to me to be analogous to the red colour of some descriptions of Heulandite, not due to the sensible presence of iron, as is shown by their forming a colourless bead in the borax flux, but probably owing to some unknown molecular condition of the particles, which affects the movements of the luminous ether.

Theory of Geological Climate.

Among the most important questions to which the attention of geologists has been called during the past year, is that of the changes of climate proved to have taken place on the globe in high latitudes, by the geological discoveries of Captain M'Clintock, Captain Sherard Osborn, and others. I think it is not going too far to say, that these discoveries will require a complete reconstruction of our theories of geological climate, as it appears to me that no theory of climate yet proposed will account for a temperature so high, in so northern a latitude as these discoveries point to.

The facts as to fossils are as follows:—

Sir Edward Belcher found bones of an *Ichthyosaurus* on Exmouth Island, lat. 77° 16′ N., long. 96° W., 570 feet above the sea level.

Captain Sherard Osborn found two bones of a reptile allied to the *Teleosaurus*, and not to the *Ichthyosaurus* or *Plesiosaurus*, 150 feet up Rendezvous Hill, lat. 76° 22′ N., long. 104° W. in Bathurst Island.

Captain M'Clintock found many Ammonites closely allied to European Liassic species, at Point Wilkie, Prince Patrick's Island, at the sea level, and higher altitudes; lat. 76° 15′ N., long. 117° W.

According to received methods of reasoning on geological climate, these facts would require us, with the present distribution of land and water, to suppose a temperature at the equator of the globe which would render it uninhabitable either by terrestrial or marine creatures.

The following theories of climate may be imagined, to explain the facts:—

First—The Secular Cooling of the Globe.—This theory would unquestionably account for the facts, but at a cost which geologists would be found unwilling to pay, viz., that the poles of the earth were first peopled, and that the migration of life was from higher to lower latitudes, as the earth cooled. This would require us to suppose that our cherished theory of characteristic fossils is false, and that the same forms of life lived in different latitudes at different times; thus making the age of a formation a function, not only of the fossil forms it contains, but also of the latitude in which it is found.

Secondly—The Change of Axis of the Earth.—If, during the period of cooling of the globe, explosions causing such dislocations of its outer crust as would change its axes of inertia took place, it is certain that the axis of rotation would change its place, and, consequently, that latitude would vary, so that a cold climate might become warm, and *vice versâ.*

I do not like to admit this theory of climate until all others have failed to explain the facts, for I think it highly improbable that any such violent dislocation of the earth's crust could have taken place during geological periods, as I am disposed to refer all such catastrophes to the Cosmogonic or Cosmopoetic period of the earth's history.

Thirdly—Change of position of Land and Water.—This theory of climate, founded on our present experience, as a *qualitative* theory, is on its trial as to its *quantitative* results. If it be a true theory, it will bear the test of numerical calculation; and, if false, it will be forgotten. I have already made some progress in obtaining the data necessary to test it numerically, but do not wish to publish them until I have obtained some positive result—this I hope to do within the next two years. It is a subject for congratulation, that the researches of our distinguished countryman, Captain M'Clintock, have mainly led to the discussion of a question, which, however it be decided, must throw much light on one of the most interesting problems of the physical condition of our globe in former periods.

Origin of Granite.

Another controversy is in store for physical geologists, of the highest interest, and one which will tend much to shake the faith of outsiders in the dogmas of the masters of our science. I mean the controversy as to the igneous or aqueous origin of the granitic rocks. The dispute between the Neptunists and Vulcanists has not been so finally decided as is commonly supposed, and the Neptunians, headed by a formidable corps of chemists, are about to take the field again in vindication of the part played by water in the formation of the granite rocks. I confess

that my own prejudices lean to the side of the water theorists, although we have been forced to silence by the overwhelming number and vociferous cries of our antagonists. The facts urged by the Neptunians are as follows:—

M. Fuchs objects to the igneous origin of granite, from the simultaneous presence in it of minerals, whose point of fusion is so very different, and from their mutual penetration, which proves their simultaneous origin. M. Bischoff bases his objections principally on the felspar, which evidently crystallized first, shooting out its prisms into the yielding quartz—a fact which is inexplicable on the igneous theory, from the well known higher melting point of quartz. I may mention that this order of solidification of constituent minerals is sometimes inverted in porphyries, as I observed last summer at Forkhill; where the quartz occurs in small double hexagonal pyramids, crystallized in the centre of the felspathic paste, showing that the quartz crystallized first, and then the felspar; an order of cooling which never occurs, so far as I know, in granites proper.

M. Heinrich Rose urges the presence of mica, a highly basic compound, in close proximity with free silica in granite, as a fatal objection to the igneous theory.

It is certainly a fact that only the tersilicated felspars are found with free silica, in the same rock mass; but it is difficult to understand, on the igneous hypothesis, how the mica escaped being converted into other more highly silicated minerals, such as felspar and hornblende. M. Heinrich Rose also urges the remarkable purity of the quartz of granite as entirely at variance with the idea of its merely acting the part of a mother liquor, from which the other minerals crystallized in succession. Gustave Rose mentions the following remarkable experiment, which goes far to prove the justice of one of the objections urged above, viz.:—That when a granite rich in silica is subjected to fusion, the felspar and mica fuse and gradually dissolve a part of the quartz, the remainder of which remains in the form of grains or nuclei in the middle of the vitreous mass.

M. Heinrich Rose has recently added to these arguments another, founded on the result of experiments on the specific gravity of quartz. It is well known that the specific gravity of quartz of granite is 2·6, and that this is also the specific gravity of quartz found in mining veins associated with sparry iron ore, brown hematite, and other minerals of aqueous origin; while the specific gravity of fused quartz is 2·3.

This argument does not appear to me to possess much weight, inasmuch as it is impossible for us to form quartz by fusion at the pressure under which it was formed in the earth, which would certainly increase its specific gravity; and the argument also proves too much, for we should expect to find hyalite or opal, and not pure silica, in granite.

In addition to the arguments above mentioned, I have myself repeatedly called attention to the presence in granite of such minerals as white mica with 4 or 5 per cent. of water, and the Hunterite of India, with 11 or 12 per cent. of water, as almost fatal to the purely igneous theory of granite.

M. Delesse also appears disposed to side with the Neptunians in this controversy, but his statements are not very precise on the matter, and he appears at present to be feeling his way to positive opinion, founded on the metamorphic phenomena of veins.

On the whole, there is no more inviting subject for research, in the wide domain of Chemical Geology, and I would request the attention of our younger members to its investigation, assured that nothing but truth can arise from the freest expression of your independent opinion, on this or any other subject, uninfluenced by the authority of so-called great names on one side or the other,—" Nullius addicti jurare in verba magistri."

Mr. J. Beete Jukes moved that the thanks of the Society be given to the President for his Address, and that same be printed in the Proceedings of the Society.

The Society then adjourned to the second Wednesday in March.

GENERAL MEETING, WEDNESDAY EVENING, MARCH 14, 1860.

Rev. Samuel Haughton, President, in the Chair.

The following gentlemen were elected Members of the Society:—1. Joseph Hone, Jun., 35, Lower Leeson-street; 2. J. F. Waller, LL. D., 4, Herbert-street; 3. Edward Fottrell, 4, Upper Leeson-street (Life Member); 4. William Foote, 23, Rutland-street; 5. Markham Browne, Connorree Mine, Ovoca (Life Member); 6. Frederick N. Greene, 46, Dame-street; 7. William G. Roberts, Ballinapack, Ovoca; 8. William Crosbie, Ardfert Abbey, Ardfert, Tralee; 9. George Ryan, 32, South Frederick-street; 10. John Lyster, C.E., Stillorgan Cottage, Stillorgan; 11. Thomas Morris, Oaklands, Serpentine-avenue, Sandymount.

The Secretary then read Sir Richard Griffith's paper "On the Stratigraphical Divisions of the Irish Carboniferous Series, as exhibited in the local Tables, prepared according to Fossiliferous arrangement, in refence to the Geological Map of Ireland."

Mr. William H. Baily, F. G. S., read a paper—

ON CORYNEPTERIS, A NEW GENERIC FORM OF FOSSIL FERN; WITH OBSERVATIONS ON THE ASSOCIATED PLANTS FROM THE COAL-MEASURES OF GLIN, COUNTY OF LIMERICK.

We are indebted to Mr. G. Henry Kinahan, of the Geological Survey, for the discovery of this remarkable fossil plant, a notice of which was given at the Meeting of the British Association in Dublin, September, 1857. I have since then visited the locality from whence it was procured, with the hope that other specimens would, perhaps, be collected, enabling me to judge more certainly of its affinities. In this, however, I was unsuccessful, and therefore thought it no longer advisable to delay its publication.

Great caution is, I am aware, necessary in describing new forms of coal plants, especially where they are, as is usually the case, of a fragmentary nature. In the specimen under consideration the characters are, however, very distinct, and its general appearance so peculiar that I have ventured upon drawing up the following description:*—

PLANTÆ—FILICINÆ.

CORYNEPTERIS (*new genus*).

(Etymology, κορύνη, a club.)

Generic characters.—Rachis grooved and striated, having closely alternating, elongate, or club-shaped pinnæ, at right angles to the stem, upon which are arranged a double alternating series of sori, or reproductive organs.

Corynepteris stellata, B. (*n. s.*).—Pl. XXI., Fig. 1*a–c*.

(Etymology, *stellata*, full of stars.)

Spec. char.—Frond pinnate, pinnules elongated and club-shaped; sori occupying the whole surface of each pinnule; arranged in two alternating series, resembling rows of small flowers; rachis striated, and longitudinally grooved.

Locality and stratigraphical range.—Coal measure shales, townland of Ballygiltenan Lower, near Glin, county of Limerick.

Remarks.—This fossil plant is of a very unusual character, appearing to be generically distinct from any before described. It is, apparently, the central portion of a fern frond, bearing about 20 elongated club-shaped pinnules. The rachis, or stem, is closely striated, and longitudinally grooved, having a flexure towards the pinnules on one side. The pinnæ, which are closely arranged at nearly right angles to the stem (five of them occurring within the space of an inch), are of an elongate and ovate form, apparently covered by thecæ or cases of the reproductive spores, which are arranged in two closely set alternating series, occupying the whole surface of each pinnule, and presenting an appearance resembling rows of small star-like flowers. They may have originally grown in spikes or clusters, forming catkins like some of the recent examples of this class, and becoming flattened by pressure.

Dimensions.

Length of fragment, ...	3 inches.
Breadth of ditto, ...	2 inches.
Length of pinnules, ...	1 inch.
Breadth of ditto, ...	$\frac{1}{10}$th of an inch.
Diameter of stem, ...	$\frac{1}{15}$th of an inch.

* Since this paper was read, it has been suggested to me by my friend, Dr. Melville, that the plant I have described may probably be the fertile frond of a species of Pecopteris. In the absence of any evidence, however, of its affinity to that or any other plant, I have thought it advisable to consider it distinct.

Affinities and differences.—I know of no form from the coal-measures at all comparable with this species in its general characters. The nearest approach to it is *Filicites scolopendrioides*, Brongniart, Pl. 137, Fig. 3, from the Grés Bigárre. There is some resemblance to the arrangement of the spores, and their star-like character, in *Asterocarpus Sternbergii*, Goëppert, Tab. vi., Fig. 1–3.

Dr. J. R. Kinahan first called my attention to the analogy between the spore cases of our fossil and that of Gleichenia—a recent tropical fern, which is figured by Goëppert to compare with the Asterocarpus before mentioned. I have also figured the under side of three of the pinnæ of this recent fern, showing the arrangement of the spore cases, for comparison, Plate XXI., Fig. 2 *a–c*.

The following is a list, with some observations on the associated plants obtained from the same black shales which forms the debris of the old coal-pits at the locality before mentioned.

PLANTÆ.

Class II.—Vasculares. Division I.—Monocotyledones.

	Occurrence in England.
Equisetaceæ (?).	
Calamites cannæformis (*Schlotheim*), . .	Coalbrook-dale.
Asterophyllitæ.	
Asterophyllites (*Bechera*), grandis,× . .	Ditto.
Filices.	
Alethopteris heterophylla (*Lindley*), *sp.* .	Newcastle, Shropshire, and Coalbrook-dale.
Sphænopteris latifolia,×	Newcastle, Coalbrook-dale.
Ditto, *sp.*	
Pecopteris oreopteridis (*Brongniart*), . .	Shropshire.
Corynepteris stellata (*Baily*).	
Sigillariæ.	
Sigillaria oculata, ...	Coalbrook-dale, Newcastle.
Sigillaria organum, ...	Ditto, ditto.
Sigillaria tessellata, ...	Ditto, ditto.
Stigmaria ficoides,×	
Linear leaves in abundance.	
Lycopodiaceæ.	
Lepidodendron elegans, ...	Coalbrook-dale.
Lepidophyllum lanceolatum, ...	Newcastle.
Lepidostrobus ornatus (*Brongniart*), . .	Coalbrook-dale, &c.

The mark × indicates the abundance of the species.

By this list it will be seen that all the fossil plants included in it,

excepting the new form, are identified with species from Coalbrookdale and Newcastle in England—an interesting fact, as confirmatory of the observations before made by me respecting the comparative identity between the Fauna and Flora of the Leinster coal-field with that of the midland counties and north of England.

One of the most abundant of the vegetable remains observed at this locality is a peculiar plant, which, from its verticillate leaves, and their arrangement at regular intervals on a jointed stem, apparently belongs to the genus Asterophyllites. This species, which occurs in much better preservation in the coal-measures of the county of Tipperary, I have referred to *Asterophyllites* (*Bechera*) *grandis*, a plant figured by Lindley and Hutton in their Foss. Fl., Tab. 17 and 19.

The most abundant of the plant remains in these shales are linear or grass-like leaves and stems, which are longitudinally striated, the leaves having a mid-rib. In some portions of the shale they form quite a matted mass, crossing and recrossing each other in all directions. They bear considerable resemblance to leaves figured by Brongniart, as attached to Sigillaria, "Hist. des Végetaux Fossiles," tome i., Pl. 161. We have here, however, no evidence of their connexion with Sigillaria. They were, perhaps, independent plants belonging to the Phanerogamia, and allied to the Graminaceæ or Grasses. With these were found well-preserved fragments of the jointed stem of *Calamites cannæformis*, a species abundant in the coal-measure shales of the South of Ireland and North of England.

In consequence of the friable condition of the shale, which has for many years been lying exposed to the disintegrating action of the atmosphere at the mouth of these old and now abandoned pits, but few species of ferns have been identified. Amongst those collected, *Sphænopteris latifolia* is the prevailing one. It is remarkable for the beautiful form of its denticulated leaflets. Other and rarer species accompanying it are the *Alcthopteris heterophylla* and *Pecopteris oreopteridis*.

With regard to size, the most important plants here, as in other coal-fields, are those of the genus Sigillaria. Several fragments of the fluted trunks of these great trees, which formed so large an element in the formation of coal, were collected, three of them being the most common forms. With these also occurred what is now considered to be its roots, the *Stigmaria ficoides*, one of the specimens showing the pits or scars to which the rootlets were attached, as described by Dr. J. D. Hooker in "Memoirs, Geol. Survey," vol. ii., pt. 2, p. 433.

The Lycopodiaceæ represented in this collection are the following: —A common and beautiful species called *Lepidodendron elegans; Lepidostrobus ornatus*, believed to be the cone-like organs of fructification of Lepidodendron; and detached acuminated leaves of the same character as *Lepidophyllum lanceolatum*, Brong., Prod., Pl. 87, and Lind. and Hutton, vol. i., Pl. 3 and 4, belonging also, most probably, to some species of Lepidodendron. This genus was also one of great importance, both with regard to size, and as contributing largely to the accumulation of the vegetable matter now converted into solid beds of coal.

Explanation of Plate XXI.

Fig. 1, *a*, Corynepteris stellata (*Baily*), natural size.
,, 1, *b*, ,, ,, one of the pinnules, enlarged 3 diameters.
,, 1, *c*, ,, ,, a single spore case from ditto, enlarged 6 diameters.
,, 2, *a*, Gleichenia (*recent*), under side of portion of a frond with three pinnæ, natural size.
,, *b*, ,, fragment of ditto, enlarged 6 diameters, to show the disposition of the spore cases.
,, *c*, ,, two of the striated spore cases, split, from having discharged their spores, still more highly enlarged.

The Secretary read Messrs. M'Dowell and Meares' paper "On the Geology of Black Head and White Head, County of Antrim."

Robert H. Scott, M. A., read a paper—

ON A NEW METALLIC ORE FROM THE CONNORREE MINES, COUNTY OF WICKLOW.

Among some specimens of ore recently sent me for analysis from the Connorree Mine was one which is stated to occur in considerable abundance in some of the new workings. It is found in the Kilmacoo Lode, in the Thirty-five Fathom Level, at Gaffney's Shaft; and, as it presents some particulars of interest, I have ventured to bring it before the notice of the Society.

The ore is massive, of a dull leaden-purple colour, containing a considerable quantity of the common bisulphide of iron, easily to be recognized by its bright colour, interspersed through it. The analysis of a portion of the entire mass yielded, approximatively, 30 per cent. of iron, 25 per cent. of zinc, and 45 per cent. of sulphur. It is, therefore, composed of the sulphurets of iron and zinc.

On treatment with hydrochloric acid, sulphuretted hydrogen was disengaged, and the solution was found to contain iron. Inasmuch as the common iron pyrites is not affected by that reagent, it was evident that the ore under examination contained a portion of its iron, in the form of some sulphuret, distinct from iron pyrites. A fresh portion was then taken, treated with hydrochloric acid, and the undissolved portion, consisting of iron pyrites, was caught on a weighed filter, dried at 212°, and estimated. The filtrate was then oxidized by means of chlorate of potash, the sesquioxide of iron precipitated by means of ammonium in excess, and the oxide of zinc, which was redissolved by the ammonia, was determined in the usual way by means of sulphide of ammonia, and subsequently carbonate of soda. The results obtained gave the following for the composition of the mineral:—

FeS_2, iron pyrites,	50·653
FeS,	12·338
ZnS,	37·009
	100·000

Although a portion of the iron seems to be present in the form of magnetic pyrites (FeS), I was unable to detect any trace of magnetic properties in the mineral. It appears, therefore, probable that the protosulphides of iron and zinc are connected together,—the iron, in fact, replacing the zinc in common Blende. This view is rendered more probable by the occurrence of distinct crystals of blende on one or two specimens of the ore.

A variety of blende, termed "Marmatite," which occurs at Marmato, in Tuscany, afforded Boussingault—

ZnS,	77·5
FeS,	22·5
	100·0

and, from its great difference from ordinary blende, it has been given a specific name. If now we subtract from our analysis the iron pyrites, and calculate the per-centage of the residual constituents, we find the composition of the ore to be—

ZnS,	74·998
FeS,	25·002
	100·000

Our ore, therefore, appears to bear a close resemblance to this variety of blende.

In the Journal of the Society for the year 1851, a paper by Professor Apjohn was printed, giving an account of an ore from the Ballymurtagh district, the description of which coincides pretty nearly with the ore at present laid before you; but the chemical composition is different, as that ore contained, in addition to the two sulphurets of iron and the sulphuret of zinc, 19 per cent. of the sulphuret of lead, which metal does not appear in the Connorree ore.

From the extreme freedom from gangue of the specimens of ore submitted to me, and from the high per-centage of sulphur, while arsenic is nearly totally absent, it cannot fail to be a very profitable ore of sulphur. The per-centage of zinc in Marmatite is 50; so that if the ore can be obtained free from iron pyrites, it may, perhaps, be found useful to work it as an ore of zinc.

GENERAL MEETING, WEDNESDAY, APRIL 11, 1860.

The Rev. Samuel Haughton, President, in the Chair.

George Smith, Esq., College-green, was elected a Member of the Society.

The President read his paper "On the Comparison of Modern Theories of the Origin of Species."

ALPHONSE GAGES, ESQ., read a paper—

ON THE FORMATION OF ORPIMENT IN A MASS OF SULPHATE OF BARYTES, FOUND INTERSTRATIFIED IN THE CARBONIFEROUS LIMESTONE NEAR SILVERMINES, COUNTY OF TIPPERARY.

SYNTHETICAL experiments can aid us very little in explaining the phenomena, often very complex, which have given rise to metallic veins. The hypotheses put forward by M. Eliè de Beaumont, in his remarkable work on Volcanic and Metalliferous Emanations, are those which hitherto best explain the general phenomena observed in the study of metallic veins.

Although it is almost certain that our hypotheses regarding the first stage or origin of these formations can never attain more than a certain degree of probability, we may at least satisfy our curiosity by the study of the secondary actions by which mineral masses have undergone, and continue to undergo, the series of transformations which so profoundly modify them, and which the experiments of the laboratory enable us sometimes to anticipate.

The observations which I am now about to offer to the Society belong to the class of secondary phenomena. The object of my experiments was to produce orpiment artificially on a substance which already contained some naturally formed traces of that mineral, with the view of finding, if possible, the way in which orpiment has been formed upon the mineral above mentioned.

The rock operated upon is chiefly composed of a mass of sulphate of barytes, coloured by sesquioxide of iron, and traversed by a series of filiform veins of galena, and arsenial iron pyrites. A slight yellow coating of orpiment was observable here and there upon it. A fragment detached from this rock, and which did not exhibit, when examined through a lens, any traces of orpiment, was immersed for some time in dilute hydrochloric acid, and afterwards washed in cold water. After this treatment, it was found to be covered by small lenticular spots of orpiment, some of them following the direction of the filiform metallic veins crossing the barytes in every direction.

In a mineral mass of this kind, containing galena associated with iron pyrites (containing sulpho-arseniurets), every condition required to form orpiment is present.

The slow electrical action that atmospheric water must necessarily develop between ores, such as galena and iron pyrites, with sulpho-arseniurets (the latter being a strong sulphur acid), suggests an explanation of the kind of decomposition which takes place.

If we admit that in the iron pyrites under consideration the arsenic exists as realgar $As\,S_2$, the general result of the decomposition may be considered to be as follows:—

1. Formation of orpiment $As\,S_3$, and of arsenious acid $As\,O_3$.
2. Sulphate of iron.

3. Free sulphuric acid, which, by its action upon galena, develops the quantity of sulphide of hydrogen required to transform the arsenious acid produced into orpiment $As\,S_3$.

Tersulphuret of arsenic (orpiment) is rarely found associated with mispickel; at least I know only of one example, quoted by Dana, of "small traces met with in Edenville, Orange County, New York."

Mispickel is not so readily acted upon by atmospheric agents as the arsenical iron pyrites; besides, circumstances such as those above mentioned must be rarely met with. Nevertheless, a specimen of mispickel from Faithleg, found associated with galena, and appearing to have undergone a slight alteration along the lines of contact of the two ores, exhibited, through the lens, traces of yellow orpiment; and its formation was further developed by the action of hydrochloric acid.

The preceding observations are merely put forward as an example of one of the ways in which orpiment may be formed under certain given circumstances. It is, however, unnecessary to observe that the same mineral may be produced under the most varied conditions, which accumulated observations can alone make us acquainted with.

Realgar, $As\,S_2$, is generally a product of sublimation; and although found in carboniferous, and other formations associated with orpiment, it is chiefly met with amongst volcanic products. Volger considers orpiment to have been, in every instance, formed by the alteration of realgar; but although it is very often the direct result of such a change, there can be no doubt that it may be formed under very different circumstances.

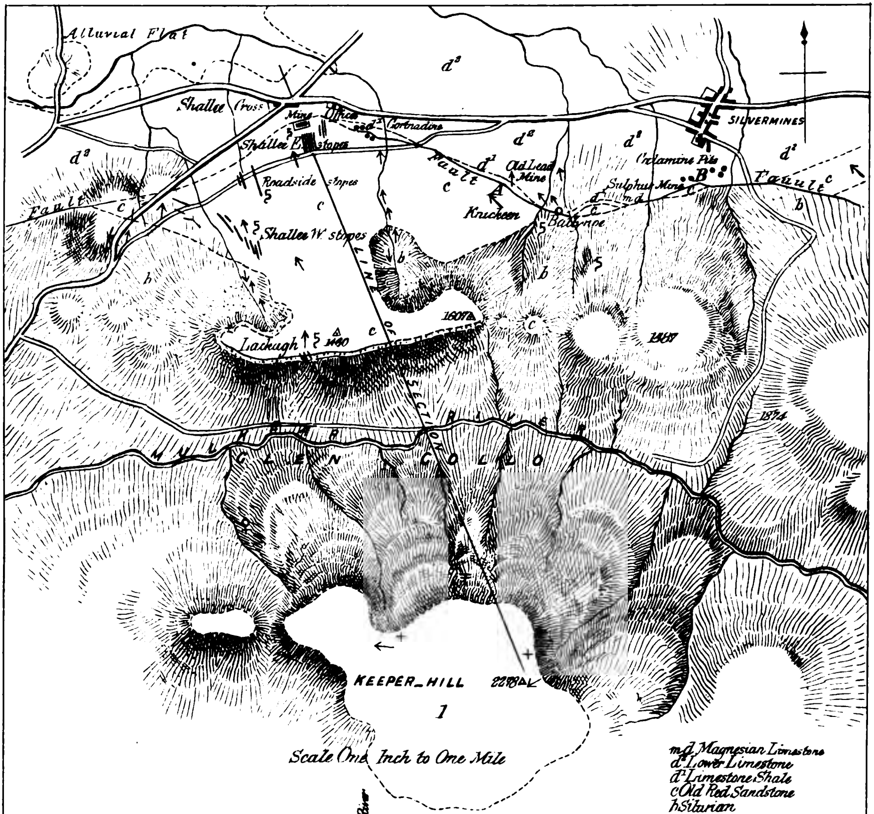
When orpiment, $As\,S_3$, occurs along with sulphuret of antimony, $Sb\,S_3$, there can be no doubt that it has not been formed out of realgar.

A. B. WYNNE, Esq., F. G. S., read—

SOME REMARKS UPON THE MINING DISTRICT OF SILVERMINES, COUNTY OF TIPPERARY WITH A MAP. PLATE XV.

THE locality to which the general name of "Silvermines" is applied is situated at the south side of the plains of Ormond, in the county of Tipperary, six miles south of the town of Nenagh, and on the northern slopes of a spur or ridge which branches from what may be called the Keeper Hill group of mountains, formerly known as the twelve Hills of Phelimghe-Macdonagh, but now undistinguished by any particular name. The mining district, a map of which will be found further on, includes a much larger portion of the hill country than of the lower ground which borders it upon the north. It is about five miles long, and rather more than four wide.

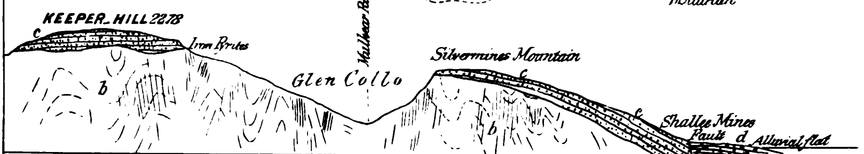
Some of the mines lying within this space were, perhaps, among the first known to exist in Ireland, as will appear from the following extract taken from Dr. Boat's Natural History of this country (p. 78), published by George Grierson at the King's Arms and Two Bibles,



1

Scale One Inch to One Mile

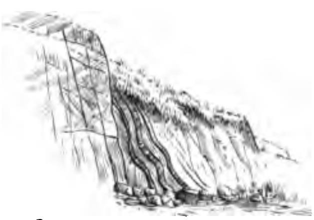
$m.d.$ Magnesian Limestone
d^1 Lower Limestone
d^2 Limestone Shale
c Old Red Sandstone
b Silurian



South   North

Vertical Scale One and a half Inches to One Mile
Horizontal do One Inch to One Mile

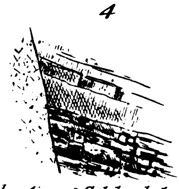
2



Junction of Lower Limestone Shale and Sandstone at A near Old Lead Mines

3

4



Junction of Sulphur lode B with mineralized and gossan beds (in the Limestone) underground at Silvermines

Wm. Campbell T.C.D.

during the year 1726. He states that there were three mines of lead and silver discovered—one in Antrim, one in Sligo, and one in Tipperary. The last is thus described:—

"This mine standeth in the county of Tipperary, barony of upper Ormond, in the parish of Kilmore, upon the lands of one John Macdermot o'Kennedy, not far from the castle of Downallie, twelve miles from Limerick, and threescore from Dublin. It was found out not above forty years ago, but understood at first only as a lead mine, and, accordingly, given notice of to Donogh, Earl of Thomond, then Lord President of Munster, who made use of some of the lead to cover the house which he then was building at Bunrattie; but afterwards it hath been found that with the lead of this mine was mixed some silver. The veins of this mine did commonly rise to within three or four spits of the superficies; and they digged deeper as those veins went, digging open pits very far into the ground, many fathoms deep,—yea, castle-deep, not being steep, but of that fashion as people might go in and out with wheelbarrows, being the only way used by them for to carry out the oar."

Sir William Russell, Sir Basil Brook, and Sir George Hamilton (cousin to the then Duke of Ormond) had this mine successively in farm from the King, and it was worked by English and Dutch operatives, assisted by Irish labourers, until the miners were attacked, and the works destroyed by the Irish during the Rebellion of 1641. After this the mines passed into the possession of the Dunally family, and have been worked under them at different times since the year 1720.*

From the extract given above, and the circumstance of Dr. Boat's alluding to the Rebellion of 1641 as the "present rebellion," it would seem that the discovery of the mines took place either in the year 1600 or early in the seventeenth century.

Mr. Thomas Weaver also described some of these mines in a paper read before the "Geological Society of London" in the year 1807, and printed in their "Transactions" (first series, vol. v., p. 242, &c.); but his observations do not seem to refer to any workings which are now open; Sir Robert Kane, too, gives a short notice of those nearest Silvermines in his "Industrial Resources of Ireland."

The geological formation of this district and the neighbouring country may be described as follows:—A contorted mass of gray shales, slates, and sandstones, containing here and there Lower Silurian fossils (a list of which was read before the Society in December last), forms the interior and principal part of the adjacent mountains, some of which are capped, and others have parts of their exterior slopes covered, by the obliquely laminated, coarse, whitish-gray, and red sandstones, shales, and conglomerates of the unconformable Old Red Sandstone. This passes

* For this information, and the use of Dr. Boat's book, I am indebted to the kindness of Lord Dunally.

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conformably underneath the dark-gray Carboniferous Limestone of the low country; but is in places separated from it by some beds of soft, black shale.

The limestone is found higher up than usual on the exterior flanks of the spur which crosses this district, and it is here brought against the lower rocks by means of a long and crooked fault, or succession of faults, which is, perhaps, a continuation of an extensive fracture that has been traced at intervals running for more than eighteen miles, from near Sixmilebridge, in Clare, by Killaloe and Birdhill, towards this place. The line of fracture crosses the whole district from W. to E., interrupting and concealing the Old Red Sandstone for short spaces along its course, and having a downthrow to the north, the amount of which it is not easy to determine, but which has disturbed the continuity of the rocks for a depth of 20 fathoms at least at Gortnadine, and displaced them for a vertical distance, probably exceeding 30 feet; its throw, however, in other places must be much greater.

The bedding of the rocks on the north side of this long fracture undulates, bringing different beds, and sometimes different kinds of rock, against the superficial line of fault; thus the limestone is brought by it into junction with the Silurian in a slight hollow on the mountain side, at a height of more than 600 feet, instead of being, as it is usually, found at the base of the hill.

The greatest thickness of the Old Red Sandstone in the district does not appear to be much more than 500 or 600 feet, and none of the workings penetrated through it to the Silurian below. Its upper part is very quartzose, and of a bluish-gray colour, differing considerably from the usual appearance of the upper Old Red Sandstone.

The limestone near the line of fracture has always a very peculiar aspect, resembling a dark-coloured dolomite, and it is indeed in many places magnesian; but some of its beds are composed of a variety of minerals,—lead, baryta, lime, magnesia, and iron, being sometimes associated in the same rock. Some of the beds contain a quantity of lead, and others consist largely of sulphate of baryta. (From what appear to be interstratified masses of the latter, occurring near Ballynoe, came the specimens noticed by Mr. Gages this evening.) Of all the sandstone and limestone rocks in the neighbourhood of the line of fracture, it may be generally said that they seem to be pervaded by metalliferous, and often by unusual mineral materials.

The drift is not remarkable except for its quantity in some localities, and, near Dunally Castle, for its peculiar white appearance. There is but little of it on the high ground, while 8 fathoms to the N. of the lode at Gortnadine, nothing but clay and boulders was met with in an adit 14 fathoms deep. In Glen Colloo, boulders of limestone from the drift are found in such numbers in the stream which flows through it, that they are collected by the country people to be burned for lime.

The metalliferous deposits are not confined to any one of the rock formations which are found here. They may be separated into three

kinds: namely, those occurring in the Silurian and Old Red Sandstone, which differ from the rest both as to their composition and direction—those which occur along and coinciding with the line of fracture alluded to above, and those which seem to occur only in the limestone.

Before proceeding to notice these, I must state that I am indebted to Captain King, who manages the mines, for many facts concerning them.

The ore raised from localities entirely within the Silurian part of the district was either galena or copper or iron pyrites. A good vein of copper is stated to occur in the townland of Coolruntha, at a place called Gold Mines; it strikes 2° N. of E., and another vein having the same direction, or else a bed charged with iron pyrites is situated higher up on the north face of the Keeper mountain, just underneath its cap of Old Red Sandstone.

Some galena has been raised, south of Ballynoe, from Silurian rocks, and some more in Lisnageenlee to the S. W., but no good information regarding these localities could be obtained. Some of them are probably those veins referred to by Weaver as being from 2 to 3 feet wide, and containing galena, heavy spar, blende, and pyrites.

In the Old Red Sandstone extensive works have been carried on at the W. side of the district, and some are still in operation (at Shallee) upon isolated groups consisting of a number of nearly, but not always, vertical veins of argentiferous galena, the width of which ranged from 8 inches to 2 feet.

These veins lay close together, being in some instances only a few feet asunder. The excavations which were made upon them show that they extended for distances of from 80 to 200 yards at right angles to the strike of the sandstones; and as the strike of these, corresponding nearly to the contour of the ground, curves round a convexity of the mountain's side, the general run of the veins radiates, although a certain local parallelism was observed between those of each particular group; some few rare instances, however, existing, in which smaller veins branched from one to the other.

The bearing of the veins in the largest of these groups (that next to Shallee), as estimated from the run of the openings or "stopes," is from 15° to 20° W. of N., and the tendency to vary towards the W. becomes greater as the distance increases in that direction; while some of the veins lying to the extreme W. curve from N. 40° W. to W. 30° N., and in the latter part of their course cross the bedding obliquely. They are here chiefly composed of sulphate of baryta.

All the works in this part of the district have been carried on at daylight, except in the group next to Shallee, where some have reached a depth of 30 fathoms.

A small group of works is situated at the very top of the ridge overhanging Glen Colloo, in and along the outcrop of the local base of the Old Red Sandstone. The veins are small, less regular than the others, and do not seem to extend into the underlying slates.

It is said that nearly all these veins had very indefinite boundaries, passing insensibly into the sandstone, instead of having a distinct wall; but in one instance, at the top of the ridge, a rib of galena, with clearly defined sides, was observed to occupy the centre of a vein of sulphate of baryta. The gangue, where there is any, consists of the latter mineral, which seems to be much more common at the western than in the eastern part of the district.

Where part of the line of fracture before alluded to, in crossing the townlands of Gortnadine and Garryard has a direction of 15° N. of W. and S. of E., it contains a great ramp or lode, which is uneven in its course, but coincides with the general direction of the fracture. Its width varies from twenty to forty feet, and it contains both copper pyrites and galena, with some crystals of white carbonate of lead in the cavities of the lode.

Access is gained to this mine by creeping through a narrow level leading from a large, open cast, which exposes part of the S. wall of the lode on one side, and a quantity of soft, black shales on the other, into an excavation from thirty to forty feet wide, more than 150 yards long, and from forty to fifty feet high. The north wall of the lode here is said to have thin bands of black shale to the depth of thirty feet, which are absent in the south one; and both of them contain bunches of galena. Following the fault eastwards, a similar lode may be traced for more than half a mile, containing here, however, a good deal of iron pyrites; and at one place, near the boundary of the townland of Garryard, a quantity of galena was raised from it. This great lode was everywhere composed of a hard brecciated mass of quartz, sandstone, and baryta, through which the ore is scattered.

Eastward of this, a natural section, A, Plate XV., exhibits the shales and sandstones in junction by means of a fault; and although the rocks here seem to be impregnated with iron pyrites, no distinct lode is seen.

Along the north side of the fault between Gortnadine and Ballynoe, there are a quantity of old workings reported to have been rich in cat-tooth, or white carbonate of lead; but they have been so long closed that little is now known about them, except that an adit driven across the place, at a depth of fourteen fathoms, ran chiefly through soft ground. A strong probability exists, that these were the works alluded to by Weaver, in the paper already mentioned, where he describes "an open space formed, probably, by the subsidence and parting of the limestone from the clay slate, several feet wide, and said to close at the depth of twenty-five fathoms." "This space," he says, "was filled with clay, sandy clay, sand, decomposed slate, and scattered blocks of limestone, lydian stone, and sandstone; the whole mass being more or less cemented or penetrated by metallic depositions, consisting of iron ochre, in various stages of induration, iron pyrites, white lead ore, galena, malachite, copper pyrites, and blende, with calcareous spar, and heavy spar." "In this softness were obtained considerable quantities of lead

rich in silver; accicularly crystallized white lead ore having been particularly abundant."

At Ballynoe a large irregular deposit of lead and copper ore occurs in a fault between the Silurian and the limestone, the ore being chiefly contained by dolomitic limestone at the north side of the fault. Iron pyrites also occur here, both in the adjacent sandstone and lower on the hill side, in what appears to be a bed of gray sulphate of baryta occurring in the limestone.

Some galena, associated with veins of baryta in magnesian limestone, is seen to the east of this, where the limestone is again brought against the Silurian by the fault.

Between these places the fault does not seem to contain any lode.

Eastward still, and apparently in continuation with this fracture, is the large open working called the Sulphur Mines. Here a great lode strikes a little to the north of east, consisting chiefly of iron pyrites, but containing some galena and a little blende. It is in one place sixteen feet wide at the surface, gaining in width as it descends, until, at a perpendicular depth of fifty feet, it is forty-eight feet wide, most of the gaining being on the south side. It seems, however, to be suddenly checked near the end of a little plantation, where a smaller lode strikes 21° N. of W., and appears to fall into another, running in much the same direction as the first, but very inferior to it in size.

Between this place and Silvermines village several old workings existed; and part of the ground is intersected in every direction by short, winding levels, excavated in a thick and somewhat irregular deposit of gossan lying between two beds of dolomite, dipping at an angle of 10° underneath the ordinary limestone, upon which the village stands. This bed of gossan is over twenty feet thick; and the thick bed of dolomite which overlies it was seen abutting against the sulphur mines lode underground.

In this bed of gossan are many lumps of argentiferous galena, containing eighty ounces of silver to the ton, with some pieces of white carbonate of lead. Large blocks and masses of the magnesian limestone also occur, as well as nodular masses and strings of a silicate of zinc, which frequently cements the gossan into a hard mass, and constitutes a considerable per-centage of the whole deposit.

Some doubt exists as to there being another bed of gossan, and sufficient excavations have not yet been made to prove its occurrence.

A portion of this gossan analyzed by Professor Apjohn (vide Journal of this Society, vol. viii., p. 157) contained about 43 per cent. of zinc.

Somewhere in this locality is probably the place referred to by Dr. Boat, where he says:—"This mine yields two sorts of oar, of which the one, and that the most in quantity, is of a reddish colour, hard and glistering; the other is like a marl, something blewish, and more soft than the red; and this was counted the best, producing most silver; whereas the other, or glistering sort, was very barren, and went most away into litteridge or dross.

"The oar yielded one with another three-pound weight of silver out of each tun; and, besides the lead and silver, the mine produced also some quicksilver, but not any alum, vitriol, or antimony, that he could hear of."

I could not discover that any ore of quicksilver had been found here; but specimens of the other ores are in the Museum of Irish Industry, 51, Stephen's-green, East, Dublin; and a Table of the values and per-centages of these is appended.

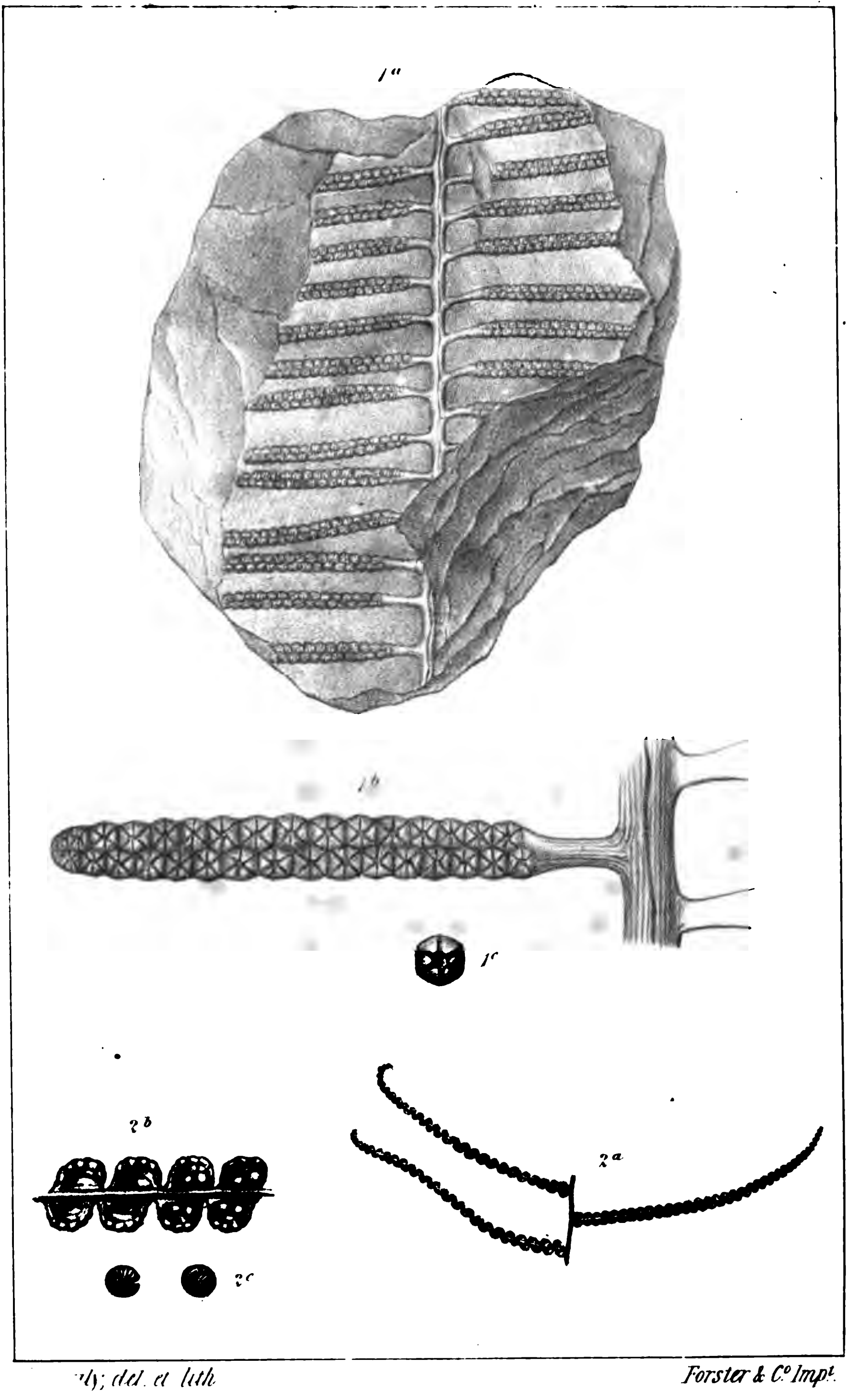
SILVERMINES.—TABLE OF VALUES, &c.

Locality.	Ore.	Proportion of Metal.	Proportion of Silver to Ton of Galena.	Value of Silver per Ounce.	Value per Ton of Ore.	Date at which the Value was ascertained.	Authority.
				s. d.			
Silvermines, . .	Argentiferous Galena,	. . . . .	3lbs. silver to ton of ore.	5 2	£11 on ground and £12 at Limerick,	1600	Dr. Boat.
Ditto, ...	Ditto, . . .	74 per cent.	80 oz.	. . . .	£24 to £25	1859	Capt. King.
Ditto, . . .	Sulphur, Iron pyrites,	35 per cent. sulphur,	. . . .	. . . .	£1 5 0	Do.	Do.
Ditto, ...	Calamine, .	50 per cent.	. . . . .	. . . .	£2 5 0 and over,	Do.	Do.
Shallee East, .	Argentiferous Galena,	72 per cent.	45 to 50 oz.	. . . .	£19 10 0	Do.	Do.
Shallee West, .	Ditto, . . .	66 per cent.	50 to 55 oz.	. . . .	£18 4 0	Do.	Do.
Lacka, ...	Ditto, . . .	70 per cent.	50 oz.	. . . .	£18 to £20	Do.	Do.
Gortnadine, . .	Ditto, . . .	68 per cent.	20 to 25 oz	. . . .	£15 0 0	Do.	Do.
Ditto, ...	Copper, . .	6 to 7 do.	6 oz. . . .	. . . .	£6 0 0	Do.	Do.
Ballynoe, or Gortahanroe,	Ditto, . . .	9 to 10 do.	6 to 8 oz. .	. . . .	£9 0 0	Do.	Do.

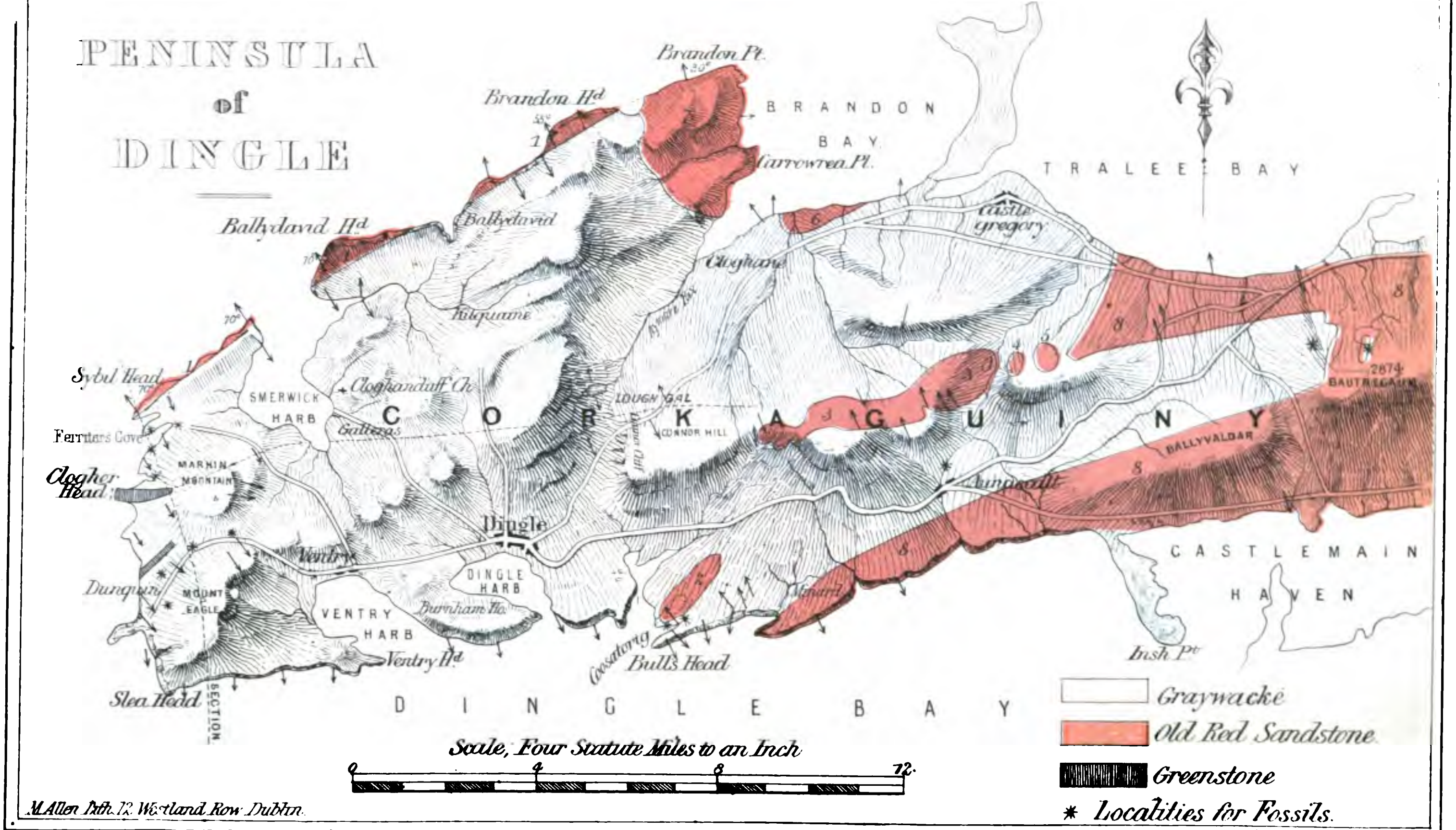
GENERAL MEETING, WEDNESDAY, MAY 9, 1860.

The REV. SAMUEL HAUGHTON, President, in the Chair.

THE following gentlemen were elected Members of the Society:—1. Maunsel Chambers, 6, Merrion-terrace, Merrion, as Ordinary Member; 2. Dr. Edmond S. Clarke, 3, Frankfort Buildings, Upper Rathmines, as non-resident Life Member; 3. William F. Kane, 18, Trinity College, as Associate Member.



ly; del. et lith. Forster & C° Imp^t.


PENINSULA of DINGLE
Brandon Pt.
Brandon Hd
Ballydavid Hd
Ballydavid
BRANDON BAY
Carrowrea Pt.
TRALEE BAY
Castle gregory
Cloghane
Kilquane
Sybil Head
SMERWICK HARB
Cloghandaff Ch
Gallerus
Ferriters Cove
Clogher Head
MARHIN MOUNTAIN
C O R K A G U I N Y
LOUGH GAL
CONNOR HILL
BALLYVALDAR
2674
BAUTREGAUM
Dingle
DINGLE HARB
Burnham Ho.
Ventry
VENTRY HARB
Ventry Hd
Dunquin
MOUNT EAGLE
Slea Head
SECTION
Bull's Head
Inch Pt
CASTLEMAIN HAVEN
DINGLE BAY
Scale, Four Statute Miles to an Inch
0
4
8
12
Graywacke
Old Red Sandstone
Greenstone
* Localities for Fossils.
M. Allen Lith. 12 Westland Row Dublin.

Mr. Kelly read a paper—

ON THE GRAYWACKE ROCKS OF IRELAND, AS COMPARED WITH THOSE OF ENGLAND.

The object of the following paper is two-fold:—First, to give a short account of some of those fossiliferous districts of Graywacke in Ireland, which have been partially examined, but no account of them published, to show their physical relations with other rocks, or the superposition of any recognised fossiliferous zones within the localities. Secondly, to make comparisons of the Irish with the English and Scotch districts, so as to ascertain those features in which they differ or agree.

The Graywacke rocks in Ireland are very extensive. They occupy parts of twenty out of our thirty-two counties. There is a large district in Ulster, in the counties of Down, Armagh, Louth, Monaghan, Cavan, and Longford, in which no fossils have been found until very recently. I might add that, so far as I know, they were never looked for. This district appears to be an extension of the Graywacke rocks of Scotland, in which there are certain fossiliferous districts pretty well explored. Professor Thomson, of the Queen's College, Belfast, informs me that he has recently obtained Graptolites in several localities in the county of Down. It is to be hoped he may continue his examination, and make further discoveries.

There are five remarkable fossiliferous districts of those rocks in Ireland, which it is my purpose to give an account of in this paper.

1. The first of those, beginning at the north, is in the county of Tyrone. This has been well worked out by General Portlock, R.E.
2. Galway and Mayo.
3. Kildare and Dublin. Those two, though thirty miles asunder, are so much alike in their mineralogical character, and in their fossils, that they may be put into one district.
4. Parts of Wicklow, Wexford, and Waterford, in the south-east of Ireland.
5. The promontory of Dingle, in the county of Kerry.

From those five districts, I have been instrumental in making collections, which were afterwards examined and described by Professor M'Coy, and the results recorded in "The Silurian Fossils of Ireland" which he wrote, and which was printed by Mr. Griffith (now Sir Richard). There has been an extensive collection also recently made on the Geological Survey of Ireland, part of which is laid out and named in the public collection of the Museum at Stephen's-green, Dublin. The available part of those fossils are chiefly from Waterford and Kerry.

County of Galway.—There may be doubts, in Tyrone, Kildare, Waterford, and Kerry, as to the identity of the lower or upper fossiliferous zones of the Graywacke, but there is no doubt in Galway. The base and the lower beds of the formation are there well exposed. There is not perhaps in Europe a country which shows better the bottom beds or lowest zone of that system.

In describing, therefore, the fossiliferous Graywacke districts of Ireland, I shall begin with the second of those above enumerated, which lies in this county. This has been called the Cunemarra district. *Cuan na marra* is Celtic, and signifies *The bays of the ocean*, and never was there a more appropriate name. Round its shores there are twenty bays, some of which are very good for the shelter of vessels. I need not enumerate their names in a geological paper.

The Cunemarra Graywacke district is in length from Devlin Point, north of Killary Harbour, on the west, to Tourmakeady near Lough Mask on the east, twenty-four miles; and in breadth, on the meridian of Leenane, from the north at Glenkeen, to the south at Munterowen, about nine miles.

The physical features of the district are very grand. One of the finest of these is Killary Harbour, an inlet of the sea, about nine miles long and half a mile wide, which divides the district for its own length into two parts. It has bold rocky shores and deep water. Lough Mask lies upon the east side of it, a noble sheet of water, about thirty-six square miles. The rivers mostly run in deep narrow glens. They are Bundorragha, Glenummera, the Erriff, and Owenmore on the north, and the Blackwater on the south.

There are to the north of the harbour four groups of mountains, separated from each other by deep defiles, in some of which the rivers flow.

1. The first of those on the north-west is the Muilrea group in Mayo. Muilrea Mountain rises steeply from the north side of the harbour, in the distance of a mile from the shore, to 2488 feet at the summit. In the same group are two other high points, about a mile distant: Glencullen, 2610; and Glenconelly, 2618. A finer distance for a picture could scarcely be got than this group, as seen from the neighbourhood of the Leenane Hotel.

2. The second group reaches from Doolough, on the south-west, to Owenmore Bridge, on the north-east. This group includes Glenummera Mountain, which rises from Doolough, very steeply, to 2474 feet. From a mile to two further north-east are two points on the large townland of Laghtoughter, 2504 and 2402 feet respectively. South of these is Glenlaur, 2184 feet. The Owenmore River bounds this group on the east.

3. The third lies between Bundorragha River on the west, and Erriff River on the east. Within these precincts are Ben Creggan, which rises from the glen at Delphi, in less than a mile, to 2283 feet, and Bengorm, another summit south of that, 2286.

4. The fourth mountain group lies to the west of Lough Mask, between Loughnafooey on the south, and Loughnageltia on the north. Near the county boundary on the south, in Galway, is Shanafarraghaun, 2218 feet. This rises from Loughnafooey 1800 feet in one mile, in a few successive steps, or terraces with precipices between them. Further west is a summit called, on the Map of Galway, the Devil's Mother, 2131 feet. This name, not being Irish, I suppose was given to it by the sappers employed on the Ordnance Survey, for it must have been an awfully troublesome place to them, as they were obliged to measure the

sides of all the great triangles on that survey, by chaining, or by other means, whether on level ground or over precipices.

There is a high point on the townland of Leenane, which rises from Killary Harbour, southward, to 2052 feet. The north face of this mountain forms a grand amphitheatre of precipices in the landscape, and seems as if a great slip had taken place on a curved plan, half a mile in length, and the north part of the hill let down from the south, leaving the precipices between the two parts.

The greatest heights in Galway are Benbane in the Twelve Bins of Cunemarra, 2395 feet, and Bencorr, 2336. These are on quartz rock and mica slate.

Mica Slate.—Sir R. I. Murchison, in his Siluria, Ed. 1859, p. 192, says that he looks upon the mica slate and quartz rock of Cunemarra, which underlie the fossiliferous groups unconformably, to belong to the Silurian system; that they are nothing else but altered Silurian rocks. With the greatest respect for the man, and for his general opinions, I cannot with all my endeavours bring myself to subscribe to this view. The quartz rock zones were most probably sand originally, then sandstone, and subjected to metamorphic action, thereby changing it into hard white quartz rock. The mica slate, in like manner, was mud, then clay slate, and metamorphosed into mica slate. Both kinds were deposited in our north-west counties in zones of great thickness. I can easily believe in the theory that the clay slate might have been converted into mica slate, or even go a step further, that it might have been melted, and become greenstone; but I cannot believe that the gray hard grits, such as those in the Graywacke, were altered into mica slate, exactly similar to the other in every particular, of hardness, colour, and grain, and this condition of the rocks must have taken place if the theory be true.

The mica slate of Antrim, Derry, and the other north-western counties, is of very ancient type, and the bands of great thickness and uniformity of colour, and mineral character. The same particulars of volume and character apply to the quartz rock in Donegal, Mayo, and Galway.

The Graywacke of Down and Cavan, and the other counties where it is, usually occurs in beds of gray hard grit, of various thickness, of from one to fifteen feet, interlaminated with clay slate, either gray, green, red, or purple, in beds or bands of about the same thickness. The bands, however, are sometimes of much greater thickness, and in such cases slate quarries are frequently opened in them.

The grit and slate being thus interlaminated in the Graywacke, I cannot conceive how a mass of 1000 feet thick of such a mixture could be converted into pure mica slate, a rock very homogeneous in aspect, grain, and colour, and there are localities in Derry, and the north-western counties of Ireland, where such homogeneous mica slate is 10,000 feet thick, or more, without a single bed of quartz rock in it.

The case is similar with the quartz rock. There are some zones of it in the north of Innishowen in Donegal, several thousand feet thick, with-

out any mica slate or mica, except in the thin partings of the beds, one-eighth or one-sixteenth of an inch. It is uniformly of a yellowish-white colour, in very regular beds of from one to three feet in thickness, extremely hard, and, when broken into thin chips, translucent at the edges, like flint. The hard white quartz rock of one locality thus makes a strong contrast with the soft gray mica slate of another. Nowhere in Leinster or Ulster does the Graywacke present any such volume of unmixed slate or grit as is to be seen in the mica slate and quartz rock zones of the north-western counties.

An opponent in this matter might say, why should there not be pure sand enough, or mud enough in one deposit to make a zone of quartz rock or mica slate 1000 feet or 5000 feet thick. I can only say that I do not know why there *should not be* such volumes of sand or mud, but I do know that in the Graywacke of Ireland they *are* not.

To meet the conditions of this theory, it would have been necessary that those usually thin layers of hard grit and soft clay slate in the Graywacke, as interlaminated, should have been converted in the mass into soft gray homogeneous mica slate; and, on the other hand, that a group of beds, exactly similar, should have been converted in the adjacent zone into such thick, hard, white homogeneous bands of quartz rock as I have described; and be it remembered, that where mica slate and quartz rock are interstratified, the white, hard quartz rock and the soft, gray mica slate meet in contact suddenly, without any gradual passage.

There is, however, some colour for Sir Roderick's views on the flanks of the granite district of Leinster, which extends from the Black Rock, near Dublin, through several counties, to Brandon Hill, in Kilkenny. The slate rocks in Kildare and Wicklow, stretching from Rathcoole by Blessington to Dunlavin, on the west flank of this granite ridge, have a south-west strike, and a south-east dip towards the granite. On the east from Killiney to the Powerscourt Waterfall, and thence to Kiltealy, the slaty rocks have a south-west strike, and a south-east dip, the same as on the west side. Here it is evident that the granite broke up the Graywacke, and came through it without materially altering its strike or dip. But it has altered it in another way; the gray clay slate at both sides is now mica slate for a distance of from one to two miles from the junction, where it re-assumes the usual, and loses the micaceous character, by a gradual passage. Here, then, is old clay slate altered into mica slate, which bears out Sir R. Murchison's view, so far as it goes.

I have just spoken of the slates, but not of the grits. Those grit rocks of the Graywacke, wherever they appear to have been exposed to great heat, as is the case on the summit of Lugnaquillia Mountain in Wicklow; the Cock Mountain, in the Mourne Mountains; Cregganconroe, to the north of Pomeroy, in Tyrone; Forkhill, near Dundalk, and other places where they rest on granite, are metamorphosed, but not changed into quartz rock. They usually present the appearance of extremely hard, dark-coloured, hornblendic rocks, the fracture, in some cases, resembling that of fine-grained greenstone; but they are never changed into hard, yellow quartz rock, like that we see in Donegal, Mayo, or Galway.

The mica slate of Cunemarra, as well as that of Mayo and that of Donegal, is of the very oldest type. Not like the mica schist of Leinster, which is but partial in the country and partial in its micaceous character, the mica slate of the N. W. of Ireland has a peculiar aspect. It is gray in colour, brilliant in its micaceous character, and vast in volume, being many thousand feet thick in the western part of Derry and Tyrone, as already stated, in Donegal, in Mayo, and in Galway. Here, in the Twelve Bins of Cunemarra, interstratified with quartz rock and limestone, it attains a great elevation, and the mountains present a very grand, picturesque appearance.

The lowest stratified rock we have in Ireland is quartz rock. It occurs in the northern part of Donegal at Malin Head, where it lies on syenite. Over it comes mica slate, interstratified with limestone, with thin layers of greenstone, like beds, occasionally between them. On the north coast of Mayo, quartz rock occupies the shore for fourteen miles, dipping south-east at a low angle. The rock which is under it here is unknown, but next over it is mica slate, and there is a passage of thin, alternating bands of quartz rock and mica slate, about a hundred feet thick from where the whole is quartz rock below to where the rock is mica slate, unmixed, above. This passage occurs about 18 miles to the east of Belmullet, at the head of Glenamoy River, near the village of Belderg. From this place southward the mica slate continues, with little interruption, to Killary Harbour, where it is covered in unconformable sequence by a band of brownstone, which forms the basal band of the Graywacke on its southern border. It is chiefly on this change of character from mica slate to brownstone, and the unconformability between them, which is seen nowhere else in Ireland, that I rely to support the opinion that those are two rocks of different epochs in the earth's history as distinct as any two we know. I would again remind the reader that there is no quartz rock or mica slate above this brownstone, and no Graywacke anywhere in Cunemarra below it.

It will be seen from what I have stated that I do not believe that the mica slate of those north-west counties already mentioned can be the ordinary Graywacke, altered by metamorphic action. I do believe, however, that the mica slate and quartz rocks of Cunemarra belong to an earlier era in the earth's history, and the fossiliferous rocks between Cong and Killary Harbour are of more recent date.

The circumstance that fossils occur in the upper or Graywacke rocks of this district in wonderful abundance in some of the localities, and not a trace of a fossil ever yet found in the mica slate or quartz rock, is remarkable. From these considerations it appears to me very unlikely that mica slate and quartz, of the usual types as to volume and character, in the west of Ireland, ever were Graywacke, like that which now overlies them. From the wholly different appearance in lithological character, the fossils in the upper, and the unconformable sequence between them, I cannot think that the mica slate and quartz rock of Cunemarra is altered Graywacke, and belongs to the lower Silurian group, or that this theory will be found to be tenable.

Old Red Sandstone is a name which, I believe, has been applied by geologists to two distinct zones of rock of very different ages. M'Culloch in Scotland, and Phillips in Yorkshire, have called the lowest zone of the carboniferous rocks by that name. Sir R. I. Murchison, and after him other English geologists, have called the brown, gray, and green grits and shales of Herefordshire and Brecknock, with their cornstones, by the same name. Comparing those two, the former I have never seen resting conformably on the rocks which support it, whether mica slate, quartz rock, or Graywacke. The latter is said by the author to lie conformably on the Silurian rocks of Shropshire and Herefordshire. The former zone, in Ireland, averages about 1000 feet in thickness; the latter, in Herefordshire, is said to be 8000 feet. I look upon the two zones thus described, and called by the same name, as belonging to two different eras in the history of the earth.

The Old Red Sandstone of Scotland and Yorkshire, the lowest zone of the carboniferous series, occurs in Ireland also. I have given a table, in which there are 78 localities in Ireland where good junctions of this zone with the inferior rocks are recorded.* The Herefordshire type, too, very characteristic, occurs in four or five parts of Ireland; but there it is associated with bands containing Silurian fossils. It especially prevails in the south, in Kerry and Cork, where it is called by the peasants *brownstone;* and, as this appears an appropriate name, for colour at least, I adopt it, for sake of distinction, as a Silurian rock, or rather a Graywacke rock.

The brownstone of Cunemarra is the key to the relations of the Graywacke with the underlying rocks. It is the lowest, or foundation zone, of that series, as already stated. It is about 300 feet thick, and rests unconformably on mica slate. Its beds are often nearly level, and can be traced in some localities for several miles. It contains no fossils, but the gray grit or schist which immediately overlies it is highly fossiliferous. It is most important, as a geological index, in exploring the district, and serves to clear up any anomalous appearances which may be seen in comparing the fossiliferous localities and their contents one with another. The beds of the brownstone are exactly parallel with those of the overlying gray fossiliferous rocks.

The outcrop of the brownstone appears mostly on the southern border, and the accumulation of the superior gray beds appears to be northwards. I do not happen to know whether the tall cliffs of Maumetrasna and Shanfarraghaun, which rise 2100 feet above the level of Loughnafooey in a mile of distance, are fossiliferous or not. Some of the precipices are quite inaccessible, and grander features are seldom seen in a landscape. I shall, therefore, confine my observations to what I know in the lower parts of the country, on the south, which are easily accessible.

The outcrop of the brownstone rises over the hills or ridges, and dips

* "Journal of the Geological Society of Dublin," vol. vii., p. 119.

into the valleys with the underlying mica slate, and may, it is hoped, be understood from the following observations, in which its course is followed from the Atlantic on the west to Lough Mask on the east:—

1. At Gowlaun, 3 miles south of Killary Harbour, on the west coast, the base of the Graywacke is at sea-level.

2. At Garraun, a high hill 2½ miles south-east of the coast, it rises to 1973 feet above the sea.

3. At Bunowen Bridge the surface comes down to 180 feet. This is about 5½ miles east of Gowlaun, and on the road from Leenane to Clifden.

4. At Glencraff, 2 miles south of the old Leenane hotel, and 3 miles east of Bunowen. The pass, which is on the junction, is 960 feet high.

5. At Munterowen, about 4 miles farther eastward, the outcrop stands at about 500 feet. Here it turns north, and appears to sink into a fault that exists from the Maume hotel up the valley of the Bealanabrack River to Munterowen, and continues on to Leenane. The strata on the east side of this fault are thrown down, perhaps 500 feet.

6. The outcrop of the brownstone is next visible in Moneenmore, about half a mile north of the Maume hotel. It is indeed visible in the stream at the road-side in the boundary between Maume east and Maume west, and thence rises in the mountain of Moneenmore to about 1000 feet high, and continues to the east visible about a mile or more farther on, falling from the summit of the pass by slow degrees, till it gets buried under the drift of the valley of the Crumlin River.

7. Again, at Boocaun the brownstone band appears, and continues 5 miles through Cloughbrack, lower, middle, and upper, into Drishaghaun. It cannot be traced farther, on account of a thick covering of drift and bog on the side of the mountain.

8. Kilbride is the next locality. This is a peninsula which runs eastward into Lough Mask, between two estuaries of that lough. The brownstone here does not rest on mica slate, but on a magnificent coarse-grained, brownish porphyry, which is seen at the top of the hill 1230 feet above sea-level. The porphyry appears to have come up between the mica slate and the brownstone, and may be 700 feet thick in the middle of the protrusion. The brownstone lies to the south of this porphyry, which assumes a long lenticular form. In Kilbride, which is about four miles long from east to west, the brownstone zone on the east rises out of Lough Mask, attains an elevation near the middle of about 800 feet, and its outcrop falls westward again to the river at Finny, which is about 70 feet above sea-level. From this it rises again through Drin to the top of the hill south of Loughnafooey, and is no more visible, being covered on the north face of the mountain with drift, bog, and heath. In this line the brownstone shows itself for about six miles.

One of the best sections the country affords, to the south of Killary Harbour, is from Bunowen Bridge, in a north-east direction through Tullyconnor and Derrynacleigh, to Killary Harbour. It nearly coincides with the line of the public road, and its vicinity, though for the most part covered with bog, yet has knolls of rock and quarries in which the dips can be seen, and the succession can be traced.

Bunowen Bridge is on the road from Leenane to Clifden, two miles south of Killary Harbour. This locality is about 200 feet over sea-level. The brownstone band, which is usually seen at the base of the Graywacke system in this country, is not visible here; but there can be no doubt of this place being at the bottom of the system, from the proximity of the mica slate, and a red breccia, containing angular fragments of mica slate, which is seen at the south abutment of Blackwater Bridge. The mica slate is seen also in pits on the road-side south of the river. On the north of the river the ground is low; no rock is seen for about 200 yards, and the brown band may be either buried in a fault near the line of the river, or covered over with the drift and bog.

This locality is remarkable for bands of conglomerate from ten to twenty feet thick, which rise up here and there out of the bog in low precipices. The conglomerate is composed of pebbles of brown quartz rock, embedded in a paste of gray sand, with a little lime and iron. The pebbles are very hard, very round, and well worn down, and are from six or eight inches in diameter down to the size of grains of shot. If broken into thin chips, they are translucent at the edges.

Between the bands of conglomerate there are bands of calcareous grit from three to ten feet thick, and in these are layers, or rather grooves, from one to three inches in thickness, composed almost entirely of fossils. The *Atrypa hemispherica* occurs in countless numbers. Those lower rocks in Bunowen, including conglomerates and sandstones, may be 500 feet in thickness. Tullyconnor lies on both sides of the road, immediately north of the townland of Bunowen. The dip of all the rocks here is northward, and the rocks of Tullyconnor appear to lie in regular succession over the conglomerates of Bunowen. Dark-gray, hard schist is the prevailing rock. The locality is about 250 feet above sea-level, and those dark schists at their upper part may be 800 feet, geologically, above the base at Blackwater Bridge. It is not easy to make an estimate of thickness here; the whole surface is covered with bog, only a small hummock of rock appearing here and there through the boggy surface.

The dark-gray schists of Tullyconnor are succeeded by thick beds of gray grit in Derrynacleigh. Those beds are not well seen in the flat ground on the road-side, but are well exposed in the hill eastward. Towards the summit of this hill, near the junction of the townlands of Derrynacleigh, Glencraff, and Leenane, there are many bands of slate in which the colours red and gray alternate, interstratified with the grits. The red slate here is apparently in the continuation by strike of a group of red slate-beds, which occur a mile to the west of Salrock House, in Culfin townland, near the mouth of Killary Harbour, the rocks in both localities having the same north-west strike. The Graywacke of Derrynacleigh and Leenane is a strong, coarse-grained, greenish grit, occasionally alternating with gray grit, and gray and red slate. In the grit there are round boulders of granite from 18 inches in diameter downwards—very frequently the size of a man's head. They are plentiful, about a mile to the west of Leenane village, both above and below the road, in loose rocks that tumbled down from the cliff; and again below the road,

where the rock is *in situ*, they are well seen between high and low water. Those boulders of granite appear to be of the same red kind as that which occupies the north coast of Galway Bay for forty miles. In this section, across the strata from Blackwater Bridge to the shore of Killary Harbour, in the middle of Derrynacleigh, the rock has a regular dip to the north-east of about 20°; and this, on a distance of 2½ miles, gives a thickness of 5680 feet in this part of the section.

Here, however, the continuity of the section is broken off at the water edge; for, although the dip continues to the north of the harbour for half a mile, there is much uncertainty in any calculation founded upon the data that exists, because there is a synclinal hollow on the west side of Lettereeragh Mountain in the line, and because bands of conglomerate, composed of brown quartz pebbles exactly similar to those at Bunowen, occur here near the synclinal line abundantly, which are well exposed in the stream of Shrughaungarve, a mile north of the harbour. There may be a fault in the line of Killary Harbour; there may be a fault in this synclinal hollow, through the medium of which the conglomerate bands are repeated; or there may be other disturbances. There are, at all events, two parallel dykes of porphyry pursuing an easterly course from Bundorragha, a little to the south of the synclinal line; they are from thirty to forty yards in breadth, and stand in high relief over the surface of the ground, both in the valley and on the hill-side.

As the section cannot be satisfactorily pursued from Killary Harbour to the north-east, I shall transfer it farther east. The northern of the two estuaries of Lough Mask, or that which runs up to Sranalong, lies at the base of a series of precipitous cliffs, some of them nearly perpendicular, and about 1000 feet high. They continue westward by the north side of Loughnafooey, which is 97 feet above the sea. The mountain to the north of that lough rises to 2218 feet in two miles distance, of which a great part is in precipices and small terraces. The beds of rock appear to lie nearly level in those precipices, or with a slight dip to the north. Here, then, there appears to be a solid vertical thickness of above 2000 feet of Graywacke, visible at once to the eye, without any diminution or allowance for slips or faults.

I know not whether there are fossils in those precipices, as I have already stated; but I know that about two miles south-west of Tourmakeady Lodge, on the west side of Lough Mask, there is a bed of limestone which has been quarried for lime. It yielded half a dozen obscure fossil fragments, and a good *Leptæna sericea*. This limestone appears to be in position above all the precipices.

Localities for Fossils.—I shall now proceed to give a short account of the fossiliferous localities of the district.

1. The first that I know of these, beginning at the west, is in the townland of Bunowen, which lies immediately north of Bunowen Bridge, or Blackwater Bridge, which it is as often called, three miles from Leenane, on the Clifden road.

This locality abounds with bands of very coarse conglomerate, as I have described in the section, which shows itself in perpendicular steps,

or small cliffs rising out of the bog, mostly under twenty feet high. Between the zones of conglomerate are bands of a calcareous sandstone, from three to ten feet in thickness, and in this there are layers, from one to three inches thick, composed almost entirely of fossils. The *Atrypa hemispherica* occurs in myriads. They remind one of a succession of oyster-beds, so thickly are they heaped one over the other in the layer. There have been but few other fossils got here. There is not much variety, and there are no corals or crinoids; but what is wanting in variety is made up in the millions of individuals. The calcareous sandstone in which they are embedded, when sound, as it is in the interior of the rock, is extremely hard to break. The conglomerate bands have no fossils. Those found in the calcareous sandstone are:—

Atrypa hemispherica.	Rhynchonella serrata.
Orthis elegantula.	Spirifer plicatellus.
Rhynchonella nucula.	Orthoceras coralliforme.

2. The next locality is Tullyconnor. This townland adjoins Bunowen on the north-east, and lies, like that, on both sides of the Leenane and Clifden road. This locality has been partly described already as the second in the section. The peculiar conglomerate bands of Bunowen entirely cease here. The rock is a very dark-gray schist, hard enough, and used for repairing the roads. The fossils are rather scarce in this dark schist, and they are different from those in Bunowen, as fossils in schist are usually different from fossils in grit or in limestone. They are:—

Halysites catenularius.	Euomphalus funatus.
Petraia bina.	Holopella obsoleta.
Orthis elegantula.	Orthoceras coralliforme.
Strophomena depressa.	" filosum.
Orthonota rigida.	" gregarium.
" semisulcata.	

3. Lettershanbally lies to the east of Bunowen from one to two miles. In this townland the southern or lower part of the Graywacke rock is, like that at Bunowen, composed of conglomerates and calcareous sandstones; the northern part has dark schists like those of Tullyconnor. There has been some confusion in recording the fossils of this locality. I have no trustworthy list; but, as well as I recollect, no species was found here but such as were also obtained at Bunowen or at Tullyconnor.

4. Glencraff is two miles south-west of the old Leenane Hotel, and three miles east of Bunowen. There is a low pass here from the east side of the mountains to the west. The lowest part of it is about 900 feet, but it rises both north and south to 1500 or 1800 feet. On the north side of this pass the fossils are found. The junction is in the low part of the pass; mica slate, with beds of gray crystalline limestone, occurs to the south; while the rock to the north is all gray grit and gray slate, with a good deal of red slate farther north towards the top of

Glencraff Hill. The fossiliferous slate in the pass is not so hard or so dark as the schist of Tullyconnor. The fossils are:—

Ptilodictya dichotoma.	Rhynchonella navicula.
Tentaculites anglicus.	,, serrata.
Calymene Blumenbachii.	Cucullella antiqua.
Encrinurus punctatus.	Murchisonia pulchra.
Atrypa hemispherica.	Euomphalus sculptus.
,, reticularis.	Orthoceras lineatum.
Orthis elegantula.	,, striato-punctatum.
Leptæna sericea.	

5. Munterowen, the next locality, is on the west side of the road from Leenane to Maume, about a quarter of a mile from it, and three miles south of the village of Leenane. The fossil locality at this place is in the south end of the townland. The brownstone band is conspicuous here, and its outcrop is nearly level, on a roundish bluff which projects southwards into the valley. The fossils I got here are:—

Stenopora fibrosa.	Rhynchonella serrata.
Tentaculites anglicus.	Strophomena depressa.
Calymene Blumenbachii.	Platyschisma helicites.
Encrinurus punctatus.	Orthoceras subgregarium.
Atrypa hemispherica.	

6. At Moneenmore, half a mile north-east of the Maume Hotel, high up on the side of the hill, there is a rocky spot which is fossiliferous. There is especially one bed of gray calcareous grit, about five feet thick, full of fossils. They are:—

Tentaculites Anglicus.	Trochonema tricincta.
Encrinurus punctatus.	Murchisonia articulata.
Stygina latifrons.	Holopella conica.
Atrypa hemispherica.	,, obsoleta.
Rhynchonella serrata.	Raphistoma lenticularis.
Avicula bullata.	Orthoceras angulatum.
Cucullella ovata.	Bellerophon trilobatus.

7. Boocaun is the next district in connexion with the brownstone in which fossils are found. This place is a mile west of Fair Hill, a village between Lough Corrib and Lough Mask. The fossils found here are:—

Spirorbis Lewisii.	Pterinea sublævis.
Tentaculites Anglicus.	Nucula grandæva.
Beyrichia Klodeni.	Orthonota solenoides.
Cyphaspis megalops.	Euomphalus subcarinatus.
Encrinurus punctatus.	Holopella obsoleta.
Stygina latifrons.	Trochus multitorquatus.
Atrypa hemispherica.	Turbo tritorquatus.
Pentamerus oblongus.	Bellerophon dilatatus.
Rhynchonella serrata.	,, trilobatus.
Avicula rudis.	Orthoceras bullatum.
Pterinea lineata.	,, subgregarium.
,, retroflexa.	

8. I have already described the position of the brownstone of Kilbride, and have only to add, that the fossiliferous band lies over it as far as it can be traced westward, being about six miles from the point of Kilbride. The fossiliferous rock here is a calcareous flag, rather brittle, and easily split, thus standing in strong contrast with the extremely tough, calcareous sandstone of Bunowen, in which the *Atrypa hemispherica* is so plentiful. Corals occur here in great abundance, the bases of some of the bunches of *Favosites Gothlandica* being from one to two feet in diameter. The best part of this locality to get fossils is at the eastern point of Kilbride, on the shore of Lough Mask. The fossils obtained here are:—

Alveolites Labechei.	Atrypa hemispherica.
Cœnites intertextus.	,, orbicularis.
Favosites alveolaris.	,, reticularis.
,, cristata.	Discina perrugata.
,, Gothlandica.	Leptæna quinquecostata.
,, multipora.	,, transversalis.
Goniophyllum pyramidale.	Lingula attenuata.
Halysites catenularius.	Orthis calligramma.
Heliolites interstinctus.	,, elegantula.
Omphyma turbinata.	,, flabellulum.
Petraia bina.	,, hybrida.
,, elongata.	Pentamerus globosus.
Stenopora fibrosa.	,, undatus.
Syringopora fascicularis.	Rhynchonella Wilsoni.
Beyrichia Klodeni.	Spirifer plicatellus.
Cheirurus bimicronatus.	Strophomena depressa.
Encrinurus punctatus.	,, imbrex.
,, variolaris.	Orthonota semisulcata.
Illænus Bowmanni.	Murchisonia cingulata.
Phacops Stokesii.	Orthoceras angulatum.

The eight foregoing localities are part of the lowest undoubted fossiliferous zone of the Cunemarra district. The brownstone band lies under them, and that upon mica slate unconformably, as already stated. No evidence can be clearer, and it is only here it is indisputable. In the five other localities of the district, the rock immediately under the fossiliferous band is not visible. Those five localities are Tonlegee, Coolin, Ardaun, Cappacorcogue, and Shanballymore. These, perhaps, might be disputed as belonging to one or more higher zones in the system than the eight localities just described; but the exact resemblance of every one of them, in lithological character and in fossils, to one or other of those described, makes it appear that it is most unlikely they belong to any higher zone.

9. Tonlegee is about six miles west of Cong. This townland lies on the north-east flank of Benlevy, a mica slate mountain, 1375 feet high. There is no brownstone band visible, but a man can stand upon the junction of the mica slate and Graywacke, and see the mica slate in crumpled layers, and the Graywacke in even bedded strata, lying level

against it. Those level beds are but short, they are soon broken off, as if the valley eastward had sunk down—or if Benlevy had been elevated, and thrust up through the newer strata, bringing up those stumps of the strata in their original position with respect to the mica slate. The most beautiful specimens of *Bellerophon trilobatus* were got in those Graywacke flags, which, on account of the absence of the brown band, I cannot say are at the very bottom, for the brownstone is the great zone of reference after all. The fossils obtained here are:—

Cyphaspis megalops.	Holopella gregaria.
Encrinurus punctatus.	,, plana.
Phacops sublævis.	Murchisonia articulata.
Atrypa hemispherica.	,, inflata.
Orthis calligramma.	Platyschisma helicites.
,, elegantula.	Raphistoma elliptica.
Rhynchonella serrata.	Trochonema trochleatus.
Strophomena compressa.	Trochus multitorquatus.
,, depressa.	Turbo tritorquatus.
Anodontopsis bulla.	Orthoceras semipartitum.
Ctenodonta obliqua.	Bellerophon carinatus.
,, subcylindrica.	,, expansus.
Nucula grandæva.	,, trilobatus.
,, semisulcata.	

10. Coolin is four and a half miles west of Cong. Coolin Lough lies in the bottom of an area which is basin-shaped on three sides, the north, the west, and the south. It stands at 535 feet above sea level. The edge of the basin on the north adjoining Boocaun rises to 872 feet, on the west to about 800 feet, and on the south the Graywacke, with its fossils, is found resting on the side of Benlevy at about 1000 feet above sea level. On the east there is a low passage where the waters from the lake make their exit, and flow on into Lough Mask. I saw no brownstone in this townland, and the beds containing the Atrypa hemispherica were not found in it either. Indeed, there is very little rock visible in it. The stream which flows into Lough Coolin from the west is the only place I know in it for fossils. Those obtained here are:—

Favosites cristata.	Atrypa orbicularis.
,, multipora.	,, reticularis.
Halysites catenularius.	Leptæna quinquecostata.
Heliolites interstinctus.	Pentamerus globosus.
Illænus Bowmanni.	Orthoceras ibex.

11. Ardaun is a fossiliferous locality. It is on the north shore of Lough Corrib, and three miles south-west of Cong. The rocks are something like those at Kilbride, slaty and brittle, and contain corals. There are a few hummocks of rock near the west boundary, in which fossils occur, and there is a by-road leading eastward through the two villages of Ardaun west and east. In this by-road may be seen thin layers of

rock on their edges, laid bare and full of fossils. The fossils I found are:—

Cystiphyllum cylindricum.	Spirorbis Lewisii.
Cystiphyllum Siluriense.	Atrypa hemispherica.
Favosites Gothlandica.	Leptæna transversalis.
Favosites multipora.	Lingula Lewisii.
Goniophyllum pyramidale.	Orthis alternata.
Halysites catenulatus.	Rhynchonella nucula.
Omphyma turbinatum.	Spirifer plicatellus.
Petraia zic-zac.	Strophomena depressa.
Stenopora fibrosa.	Goniatites cymbæformis.
Ptilodictya dichotoma.	Orthonota rotundata.
Cyphaspis megalops.	,, semisulcata.
Encrinurus punctatus.	Pleurorhynchus pristis.
Phacops sublævis.	Orthoceras subgregarium.

12. Cappacorcoge, a fossil locality, is also on the north shore of Lough Corrib, and one mile from Cong. The gray, tough, calcareous grit is visible at the water's edge on the shore, teeming with Atrypa hemispherica. Allowing three of those little fossils to occupy an inch, in every direction a cubic foot of the rock would yield 46,656 fossils; but I would say they are even more numerous, for a cubic inch contains more than twenty-seven of them. If the brown band exist here, it is some distance out in the lough. The fossils found here are:—

Favosites alveolaris.	Pentamerus oblongus.
Tentaculites Anglicus.	Strophomena compressa.
Beyrichia Klodeni.	Euomphalus subcarinatus.
Cyphaspis megalops.	Murchisonia cingulata.
Phacops sublævis.	Trochonema trochleatus.
Atrypa hemispherica.	Trochus multitorquatus.
,, orbicularis.	Bellerophon trilobatus.
Rhynchonella serrata.	

13. Shanballymore and New Village form one locality. It is two and a half miles north-west of Oughterard, on the road-side. There are many hummocks of rock on the west side of this road, in New Village, through the tillage lands, which have the usual abundance of Atrypa hemispherica, in the same kind of stone. I should state that this place is five miles south of Ardaun, and detached. The rock on the south of this little district is granite, on the west, mica slate, but I could not ascertain whether the brownstone exists along the edge of this mica slate or not, under the fossiliferous rock. The junction is obscure. The fossils obtained here are:—

Spirorbis Lewisii.	Orthis flabellulum.
Atrypa cuneata.	Rhynchonella sexcostata.
Atrypa hemispherica.	Ecculiomphalus Bucklandi.
Lingula Lewisii.	

14. Uggool, in the county of Mayo, is six miles north-west of Ballaghaderreen. Although detached, I join this into the Cunemarra district, because it is but small, the fossiliferous part being only about four miles long in a north-west direction, and about one mile wide. This locality is slaty and calcareous, and contains corals, trilobites, and shells, similar to those of Kilbride and Ardaun. The fossils got at Uggool are :—

Alveolites Bechei.	Brontes laticauda.
Arachnophyllum typus.	Calymene brevicapitata.
Cyathophyllum flexuosum.	Encrinurus punctatus.
Favosites cristata.	Proetus latifrons.
,, Gothlandica.	Atrypa aspera.
,, megastoma.	,, reticularis.
Halysites catenularius.	Orthis calligramma.
Heliolites interstinctus.	,, undata.
,, megastoma.	Strophomena corrugata.
,, petalliformis.	,, depressa.
Labechia conferta.	Murchisonia sulcata.
Omphyma turbinatum.	Raphistoma elliptica.
Stenopora fibrosa.	Bellerophon dilatatus.
Stromatopora concentrica.	

The Uggool district is connected with the west end of the Curlew Mountains, a long narrow ridge of brownstone, which extends from this place eastward to Keadue, a distance of thirty miles. It is about five miles wide, and reaches an elevation of 822 feet. The section of the strata, a little to the west of a line between Boyle and Ballinafad, shows the rocks on the south side of the ridge dipping at a low angle to the north of about 10°. On the top of the mountain there is a kind of anticlinal curve, by which the dip is changed, or rather increased, on the north, so as to plunge into the earth at an angle of about 70° under the carboniferous limestone, which borders it on that side the whole way. Where the Sligo and Boyle road crosses the ridge, near Garrow, there are protrusions of porphyry of a brown colour. No attempt at the thickness of the brownstone here can be made, for the bottom of it is not visible.

The fossiliferous rocks at Uggool consists of gray grits, impure limestones, and gray slate, which abound with fossils, both corals and shells, as enumerated. They are got in some hummocks of rock to the east of the road, and to the west of it the fossils are in the bottom of a cut that was made in the rock to conduct the water away below the bridge, as well as to make a trial for limestone, which is proved to be too impure for burning into lime. The relative position of the fossiliferous rocks here cannot be ascertained. There is brown porphyry on the south side of it, also porphyry to the north in the mountain of Mullaghanoe, and the locality is low, and much covered with drift. Similarly with the Tyrone district, the carboniferous rocks at Ballaghaderreen and Boyle dip at a low angle to the south, and lie, therefore, unconformably on the brownstone of the Curlew Mountains.

From the foregoing observations it will be seen that, by means of the brownstone, the fossiliferous zone, which lies immediately over it, is recognisable in eight different localities, as the one zone in Cunemarra, and by looking over the list of fossils got at each place the following conclusions are deducible:—

1. That in the same fossiliferous zone a colony of fossils of one kind may prevail in one locality, and another group in another. Of the fossils got in the eight localities just alluded to, no two are strictly alike.

2. That there is no rule that declares that a few species prevail in any one zone for more than a short distance, say three or four miles, but the recurrence of a colony again in another locality of the zone is frequent, at ten or fifteen miles distant.

The Cunemarra district is remarkable for the varieties in type of the rocks, as well as of the fossils, in a few miles of distance in the same zone. The Bunowen locality, with its massive layers of conglomerate and the *Atrypa hemispherica* in millions, in other layers between them, has not an exact equivalent anywhere else. There are no corals here, no Crinoids, no Gasteropods. Kilbride, like Bunowen, rests on the brownstone band, but is unlike it in other circumstances. There are no thick bands of conglomerate, but a great abundance of corals, though not many species, and there are plenty of Brachiopods in the brittle, slaty rock.

Again, at Boocaun the brownstone is still persistent as a base resting on mica slate, but the conglomerate bands are not there. The rock resembles that at Bunowen, and though only two miles from Kilbride, the lithological character of the rocks of the two is very different, one being a brittle, calcareous slate, as just stated; the Boocaun rock is a very hard, tough, calcareous grit. In fossils, too, they differ. I never got a coral at Boocaun, but Brachiopods are abundant enough, and Gasteropods peculiar and plentiful. Glencraff rather partakes of the character of Kilbride in the rock; Munterowen much the same. Maume is more like Bunowen or Boocaun, a gray, hard, calcareous rock. Those are the localities, chiefly on the brownstone base. For the others, Ardaun resembles Kilbride in its rocks, and pretty nearly in fossils too. Cappacorcogue is the exact equivalent of Bunowen in fossils and in the stony character of the rocks, though they are fifteen miles asunder. The base is in Lough Corrib, and if there be brownstone or conglomerates, they are under water. Shanballymore, near Oughterard, in rocks and in fossils is the same as Cappacorcogue, though five miles south of it, and detached by the Lough. Tullyconnor differs from all of them: the rock is a very hard, blackish schist; it contains some corals, bivalves, Gasteropods, and Cephalopods. From the dip of the rocks, this place appears to lie in a zone higher than that at Bunowen, or, at least, the upper part of the same zone.

The whole number of fossils found in the Cunemarra district is 134.

Igneous Rocks.—1. There is a protrusion of granite near Oughterard, on the S. E. side of the Shanballymore locality, which appears to have

come up between the Graywacke and the Old Red Sandstone. 2. There is a protrusion of coarsely crystalline porphyry, of a brown colour, in Kilbride, at the north side of the brownstone band; but this porphyry is under it, as already stated, and, therefore, does not break off the sequence above it. Besides the Kilbride porphyry, and the two porphyry dykes which trend away eastward from Bundorragha, through Lettereeragh, already adverted to, there are other dykes of this substance in the district. Taking a boat from Leenane, and rowing down the harbour, about a mile west of the village of Bundorragha, there is seen a series of five or six large porphyry dykes in the coast cliffs, which are from 50 to 100 feet high. Those dykes are from two to seven yards in thickness, some of them more. As a general rule, they lie parallel to the bedding of the gray grit and slate in which they occur, and have a northern dip with them of 50° to 60°; but they are not contemporaneous: they do not always lie exactly in the bedding of the rock, but occasionally break in a little upon it here and there, so as to show broken edges.

Turning eastward from Delphi, through Glenummera, there is a porphyry dyke, about 50 feet thick, in the steep hill to the south of the river. The outcrop of this dyke is nearly level, and it appears to have a dip southwards into the mountain of about 20°.

3. At Uggool, near Ballaghaderreen, a purple slaty porphyry lies to the south, adjoining the fossiliferous district there, and a flesh-coloured porphyry occurs in the top of Mullaghanoe Mountain, to the north of it; but the rocks which lie in immediate contact with the fossiliferous band cannot be seen. On the north side of the Tyrone district there is a granite protrusion, of which I shall say more when I come to describe that locality. From my experience, I believe that protrusions of granite or of porphyry are evidence generally of disturbances which occurred since the deposition of the older sedimentary rocks, and any zone, lying on such protrusion, might be of any age, from quartz rock to coralline crag.

The Pomeroy District.—The Graywacke district of Tyrone and Fermanagh, as I interpret it, extends from near the little town of Pomeroy, on the N. E., to Lisbellaw, on the S. W., a distance of forty miles, by about ten miles wide, in a S. E. direction, between Omagh and Ballygawley. The chief part of this area is occupied by brownstone, a brown grit rock, with brown and red shale interstratified through the greater part of it. The junctions with other rocks round it are rather obscure, being much covered with drift. The rocks which bound this district on the N. W. side are the mica slate of Dooish Mountain towards the S. W., and the metamorphic rocks and granite of Cregganconroe towards the N. E. Towards Lough Erne, on the west side, are limestone and shale of the carboniferous formation, and on the S. E. the carboniferous series cover up the outcrop of the brown beds from Lisbellaw, by Ballygawley, to Cookstown, a distance of about forty-five miles.

There is not much variety in the aspect of the brownstone within the area just defined. There is at the N. W. corner of it, near Lisnarrick, a remarkable conglomerate, composed of rounded pebbles of brown quartz rock, mostly from two to five inches in diameter. Those pebbles, when

broken into thin chips, are translucent at the edges. The whole mass is similar to the conglomerate bands at Bunowen, near Killary Harbour, in Cunemarra. This conglomerate is in contact with the brownstone adjacent on the S. E., and with carboniferous limestone on the N. W.

At Lisbellaw, on the S. W. corner, there is a conglomerate also, but different in character from that at Lisnarrick: it is much coarser; the well-rounded pebbles of brown quartz rock often attain a diameter of twelve or fifteen inches, and are connected by a gray, sandy paste. The church is built upon a rough hummock of this, which is quarried for the roads, and the village stands, on the slope of the hill, on the same rock. This conglomeritic band of Graywacke must be pretty low down, as there is a considerable accumulation of gray slaty and schistose beds lying over it to the north, where it is surmounted conformably by the brownstone beds, half a mile to the north of the village. This slate and schist yielded many of the Orthoceratites and a few Graptolites described by General Portlock. All the Graywacke rocks near Lisbellaw, both brown and gray, dip to the north at about 20°, and all the carboniferous rocks, which come in a little to the south of it, dip to the south-east, at about the same angle. Portlock in his section shows those opposite dips as a continued anticlinal convolution in the same series. But two distinct geological formations meet here, and the beds of the different rocks dip in opposite directions, the upper covering up the lower unconformably; and this is the case on the S. E. side of the district, by the valley of Clogher, for miles.

There are many beds of conglomerate visible low down in the brownstone in the vicinity of Ballygawley: one in a ravine, a mile to the north of it at Millix.

A mile south-east of Pomeroy, in the bed of a stream at Shanmaghry, and, apparently, at the base of the brownstone, there is a conglomerate, which is different from either of those just described, inasmuch as a portion of its pebbles are of red granite, like that which occurs four miles north of the place at Bardahessiagh.

The brownstone of Tyrone, though generally of a brown colour, is not uniformly so. On the southern border, near Clogher, there are gray and green grits interstratified with the brown, all dipping conformably to the north-west. In the low ground about Trillick and Fintona there is much soft, red shale at the surface, but the rock is seldom seen, the country being thickly covered with drift.

In the high land, to the east of Sixmilecross, there are beds of red limestone, from one to three feet thick in the brownstone, some of which are quarried for economic use. Those bands appear to me to represent the cornstones of Hertfordshire and Brecknock, and indeed the rocks of the brown district, both grits and shales are very similar in lithological character, and in colour to those of the country about Brecknock. There is a further similarity in the brown beds lying conformably on the fossiliferous rock at Lisbellaw, and, as I believe, at Pomeroy also, and a third point similar in the great volume of the thickness, that in Hertfordshire being said to be 8000 feet; this, in a section near the

road from Clogher to Fintona, where the rock dips for two miles north-west at an average angle of 40°, gives a thickness of about 7000 feet.

Another feature common to Brecknock and Tyrone is, that in both places, the shales are soft and laminated in the grits, and show no cleavage lines. This condition of the shale, however, usually occurs where the beds lie level or dip at a small angle. When they are highly inclined, the slaty beds are hard, and the cleavage very apparent.

The Old Red Sandstone of the Carboniferous series, and the so-called Old Red Sandstone of Hertfordshire, are not equivalents. They are two different things. In fact, the Old Red Sandstone overlies the brownstone unconformably in the valley of Clogher, and all along the south-east boundary of the brownstone, as already stated.

Protrusions of porphyry sometimes occur in the brown rocks, and, what is remarkable, the prophyry itself is very much of the same colour as the adjacent stratified brownstone. One of those is seen at Aultmore, four miles south of Pomeroy; another at Millix, two miles north-east of Ballygawley. There are greenstone dykes in it also. The church at Irvinestown is built on one of those, and it can be traced through the country for eight miles to the south-east from this. This dyke is above twenty yards in breadth. There are traces of another running from Fintona north-west, and of one running from Clogher to the north-west also. One exists to the south of Dóoish Mountain, and this is traceable at intervals eastwards, between the mica slate and the brownstone, to Tamlaght, a mile from Omagh, where it shows itself in a considerable protrusion.

From under this brownstone there rises up the fossiliferous district at Pomeroy, and another fossiliferous district at Lisbellaw. Those have been so ably handled by General Portlock, that I have but little to add. I shall merely give a rapid sketch, directing attention to a few points he has only partially noticed.

The fossiliferous district at Pomeroy assumes the form of a rude equilateral triangle. On the north, one side of this lies along, joining the granite and metamorphic rocks, and this, from Tremoge on the west to Mullynure on the east, is about four miles; the other two sides converge on the south at Shanmaghry; from the curving inwards of the boundary on the west, however, the area is under seven square miles.

The district is remarkable for the prevalence of sandstone or grit and schistose rocks, and the absence of pure limestone. In reviewing fossiliferous districts generally in Ireland, and in England too, so far as I know it, it appears to me that the mineral substance in which fossils are embedded has much influence on the genera and species, perhaps as much as the actual superposition, but more of this hereafter.

The fossiliferous zone of Pomeroy rests on the flank of a high, narrow-crested ridge of granite, with metamorphic and hornblendic rocks, which bound it on the north, called Cregganconroe, and which separates it from the mica slate country to the north-west in Tyrone and Derry. This ridge extends in a south-west direction from Slieve Gallion to Termonmaguirk, a distance of fourteen miles. At Limehill, on the

west, black graptolite slate rests on the granite. At Bardahessiagh, on the east, that rock supports gray sandy flags and schists. This variety shows that the rocks in contact with the granite do not belong to one group, and that, most probably, either of those bands visible at the surface is not the lower one of the formation, as might be expected in the junction with granite, an igneous rock. In fact, the lower groups appear to be buried in the depths, and not visible.

Where the sedimentary rocks are in contact with granite, they show no signs but that of induration. The mass of the beds dip south, at an angle of about 30°, but the dip is not uniform; it is sometimes as high as 60°. Since the bottom cannot be seen, it is vain to speculate on the thickness, or to attempt to determine, in the vicinity of the granite, to what zone of the Graywacke this fossiliferous band belongs. The succession does not appear to be regular, nor are the groups of beds traceable for any great distance on the strike. On the contrary, there are indications of lines of disturbance running north and south, elevating or depressing certain blocks of rock between them, throwing mineral masses of very different composition into the same strike.

As the rocks of Pomeroy dip southward, they are covered by other rocks at Shanmaghry, which are concealed on the outcrop by drift, with bog and heath; and we know not what they are, until at a mile farther south to the dip the brownstone is well developed on the high ground towards Aultmore, and in some ravines along the top of the slope, where they all dip away to the south-west at a low angle. A geologist regrets that he cannot see what those concealed rocks are, at or near the upper part of the fossiliferous group. The last rock seen in the succession in the valley is the conglomerate in the stream at Shanmaghry, already described. This conglomerate I suppose to be the base of the brownstone, but, from the rocks over it being concealed, as just stated, there is no certainty that this is the case.

The Pomeroy district, from its fossils only, has been called a lower Silurian district. As just stated, adjoining a great igneous protrusion, we cannot be certain whether the rocks we see in contact with it at the surface are the lowest rocks of the formation or not. In this district it appears, physically, for another reason, that they are not. In Hertfordshire the brownstone, or, as it has been called by the English geologists, Old Red Sandstone, is the uppermost of the Silurian rocks, or, in other words, it overlies them all conformably where the sequence is complete. If my views be correct, that the Tyrone brownstone is the equivalent of it, it follows that the next fossiliferous zone immediately below is the upper fossiliferous zone of the Graywacke, both in Hertfordshire and Tyrone.

If the Pomeroy group be "the lower Silurian," there must have been an upper (if such ever existed) above the brownstone somewhere, which in after times must have been totally swept away, as there is not a trace remaining of any such band over it in the forty miles from Pomeroy to Lisbellaw, any more than there is in Hertfordshire.

According to these views, Ludlow and Pomeroy would both belong

to the upper Silurian groups, a thing totally at variance with the present received notions; but more of this hereafter.

Of small tracts, differing in mineral character, there are four in the Pomeroy district. The first, lying in contact with the granite on the north-west, is the Limehill black schists, containing Graptolites. The second, also in contact with the granite on the north-east, consists of the course, micaceous, flaggy, gray sandstone at Bardahessiagh. About the middle of the tract, north of the old slate quarry, it yields a variety of Orthides and Trilobites. The third, at Tirnaskea, yields abundance of Trilobites in the coarse slaty schists on the west bank of the river, and in the bed of the river, where I worked up to my knees in water part of a day, are very fine-grained, dark gray, silky schists, which contain the most beautiful specimens of Trinucleus. The fourth is at Killey on the south-west, half a mile from the village of Pomeroy; there is a light brown sandstone abounding in Brachiopoda, near the little mill, and in the pasture hill immediately to the west of it. The whole number of fossils found in the Tyrone or Pomeroy district is 167.

It may be interesting to state that at Limehill, about two miles north-east of Pomeroy, there is a calcareous granite. On trial I found this to contain 12 per cent. of lime. It has been burned for agricultural use. From this circumstance the place took its name. The story of the discovery of the calcareous nature of the granite, as handed down by tradition, is curious. Some shepherds in former times were herding on the mountain, and, the distance being far, they took oaten cake and milk with them in the morning for dinner. Not relishing a cold dinner, they heated some of the stones in their fire, and, when hot, dropped them into their wooden vessels. The hot granite slackened at once in the milk, and hence the discovery.

The Kildare and Dublin District.—The fossiliferous locality near Kildare is two miles north of the town of Kildare. It forms a ridge of high ground, stretching in a north-east and south-west direction. About the middle of this ridge is Cahiranearla, or the Earl's Chair, a name which carries with it some traditional associations. This is a limestone rock, which stands at 600 feet above the sea, and makes a prominent feature in the landscape. The limestone is of a light gray colour, and fossiliferous. It has a dip to the south-east, and its strike is to the south-west, but dip and strike are of little use in this ridge. They are not persistent. The next hill to the east in the range is Grange Hill, a greenstone protrusion, and the Hill of Allen, still further east, is greenstone also.

The limestone of the Chair of Kildare is fertile in Trilobites and Gasteropods. It rests on a dark gray, hard schist, which abounds in Brachiopods. Corals are scarce, but the stems of Crinoids are in great abundance in a new fence, which runs north-west from Dolan's farmhouse, for a field or two, in a red calcareous slate.

The whole ridge of hills, at the Chair of Kildare, bears evidence of having been tilted up on the east side of a fault, the line of which points to the north-east. It is remarkable that at Portrane, on the

Dublin coast, the Silurian rocks appear to be thrown up in a similar way, from the carboniferous rocks lying to the north-west. Here there is a greenstone dyke protruded between the Graywacke and Carboniferous rocks. The Portrane dyke corresponds in direction with the fault on the north-west side of the Chair of Kildare ridge. This suggests the idea that the two may be a part of the same zone, and thrown up by the same disruption.

Portrane District.—Portane is on the coast of Dublin, about nine miles north of the city. This district is small, being about one and a half miles from north to south, and perhaps a quarter of a mile average width. As just stated, it has a greenstone dyke on the north between it and the Old Red Sandstone conglomerate, the base of the carboniferous system, which is in contact with it on the north side. It has greenstone, forming a group of hummocks on the south, near one of the Martello towers.

At Portrane is limestone, but of a darker gray colour than that at the Chair of Kildare. It occurs in certain parts in thin beds, interstratified with black shale. At the south end is greenish slate. On the west side the Old Red Sandstone covers the lower rocks.

The fossils got here are *Halysites catenularius, Sarcinula organum, Orthis Hirnantensis, O. elegantula, Strophomena depressa, Cybele verrucosa*, and many others.

Lambay Island, opposite to Portrane, is a great protrusion of greenstone, with many porphyritic varieties, caught up in or resting on the greenstone. On the shore are some fossiliferous beds, in Carnoon Bay, in Talbot Bay, and on the south-east side at a place called the Limekiln. There is also a small trough of Old Red Sandstone at the north-west angle of the island, lying on blackish bituminous shales. The chief of the fossils found here are *Favosites Gothlandica, Lichas Hibernica, Orthis calligramma, Orthis Hirnantensis*, &c.

On the shore between Skerries and Balbriggan, Graptolites occur in the gray slate, opposite to Hampden demesne. Half a mile south-east of Balbriggan, at Isaac's Bower, *Leptæna sericea* was got in a light gray limestone, in a calcareous bed, associated with greenstone hummocks. To the north of Balbriggan, on the shore, some species of fossils have also been found.

A high ridge, called Bellewstown, extends westwards from Balscadden to Duleek. This hill is chiefly slate, with protrusions of greenstone. The slates have yielded fossils, *Orthis caligramma*, and others.

Near Slane, in the county of Meath, Graptolites have been found in the Commons of Slane. At Grangegeeth, three miles north of Slane, there are found in hard, altered rock, *Orthis calligramma, O. elegantula, Pleurorhynchus pristis, Cybele verrucosa, Strophomena corrugata*, &c., &c.

I have thus put those few localities on the northern borders of the county of Dublin into the Kildare and Dublin district. They are too small to be made a separate district. In no part of either Kildare or Dublin has any bottom or any summit been discovered. I cannot tell, as in Galway, to what zone of the Graywacke these localities be-

long. The whole number of fossils found in the Kildare and Dublin district is 90.

Wicklow, Wexford, and Waterford.—This, the south-east district of Ireland, occupies parts of the counties of Wicklow, Wexford, and Waterford. It extends from the mountain of Carrick, near Rathdrum, on the north, to the Bonmahon Mines, on the south, 75 miles, and occupies an average breadth, exclusive of the marl, of 14 miles, making in all about 1050 square miles. There are many fossiliferous localities in it. In Wicklow, the vicinity of Rathdrum has a few such places. In Wexford are the neighbourhoods of Gorey, Enniscorthy, and Taghmon; and Waterford has Tramore and Bonmahon.

Nowhere in this extensive district is there any base of the fossiliferous groups visible, as is the case in Cunemarra; and in this respect it resembles the Kildare and Dublin district. The zone, therefore, of the Graywacke system, to which any locality here belongs, is quite unknown by physical means. It may not be amiss, however, to state, that most of the fossiliferous localities are in the vicinity of protruded rocks, such as greenstone, yellow felspathic rock, porphyry, or some such. As those protruded rocks, no doubt, were forced up from a great depth, and tore up and brought with them many blocks of the stratified rocks in their passage upward, it is fair to infer that the fossiliferous rocks lay deep in the sedimentary system; and that many of the blocks of rock containing fossils, now in contact with greenstone or felspathic rocks at the surface, were brought up from great depths; and most probable, therefore, that all those fossils belong to the lowest and oldest beds of the Graywacke system.

I cannot, perhaps, do better than give a list of the fossiliferous localities of the whole district, so far as I know them, pointing out in each case the bearing and distance of every locality from the nearest town. The following is an alphabetical list of townlands where fossils have been found in Wicklow, Wexford, and Waterford:—

Fossiliferous Localities in Waterford.—Ballydowan East is five miles south of Kilmacthomas. The rocks on the coast, in Ballydowan Bay, yield fossils.

Ballydowan West is five miles south of Kilmacthomas. There is a good locality for fossils on the shore on the west side of the bay.

Ballynasissala is two miles south-east of Kilmacthomas. The fossiliferous locality here is in gray slate, five chains east of where a shaft was sunk for mining, and between two mill-streams on the west side of the townland.

Ballynattin is one mile north-east of Tramore, ten chains east of the Waterford road, on a by-roadside which leads eastward by the shore.

Caher is two miles south-west of Tramore. The south coast, near Garrarus strand, affords a good locality. It is about five chains or twenty perches from the west boundary.

Dunabrattan is seven miles west of Tramore, on the shore. This is one of the finest localities in the county for Trilobites, Gasteropoda,

Brachiopoda, and Corals. The locality is at both sides of Dunabrattan Head.

Gibbet Hill, on the west of the city of Waterford, has black slate on the river bank, which affords Graptolites.

Kilmacthomas is a village fourteen miles west of Waterford, on the way to Dungarvan. A cutting on the side of a new road made to the north of the town affords some fossils.

Knockmahon is five miles south-east of Kilmacthomas. This is in the vicinity of the mines. The rocks on the shore are nearly all fossiliferous, and a good deal of the stuff raised in sinking the mining shafts.

Newtown is on the coast, south of Tramore. The rocks are mostly thin bands of gray limestone, interstratified with slaty-brown, decomposing layers. Those layers yield many kinds of fossils.

Newtown Head, on the shore of Waterford Harbour, is seven miles south-east of the city of Waterford. *Ampyx mammillatus* and other Trilobites are got here in a hard rock, very much resembling a greenstone.

Pickardstown is one and a half miles north-east of Tramore. The same band that passes southward under Tramore, and along the coast a mile to the south of it, occurs here, and contains the same fossils as at Newtown, which also forms a part of this band. The stone walls and ditches hereabouts would afford good help to fill a museum.

Quillia is two miles north-east of Tramore; is a very good fossil locality; there are beds of limestone interstratified with argillaceous and ironshot slates, which afford good Trilobites and other fossils.

Tramore West is on the same fossiliferous band as Pickardstown. There is a good nest of fossils on the shore opposite the church.

Westown is one mile south of Tramore. The same band of limestone that is seen at Newtown is here also. It runs through several townlands on the west side of the Tramore strand.

Fossil Localities in Wexford.—Balcarrig Hill is six miles south-west of Gorey. The fossiliferous locality here is near a cross-road which leads to Cross Pottle, and the fossils are got on the north side of the road.

Ballybro is ten miles south-east of Wexford. There is a fossiliferous locality a mile to the north of the village of Tagoat.

Ballinatray Lower is three miles south-east of Gorey. To the south of the river there is a calcareous slaty band, which is very fossiliferous. It stretches nearly parallel to the line of the river, both to the east and west of the bridge. Again, in the south end of the townland, there is a band of light-gray limestone, from ten to fifteen feet thick, which crosses the River Chapel. There are marks of fossils in this limestone, but it is very close-grained, and it is extremely difficult to get them out.

Ballydaniel is six miles south-west of Gorey, and a mile north-east of Camolin. On the east side of the coach-road, at the edge of a greenstone protrusion, the fossils are got.

Ballygarvan is seven miles south-east of New Ross. Some rocks on the south side of Ballygarvan Bridge yield fossils. It is a good locality for Trilobites and Orthides.

Ballykale is two miles south of Gorey, on the east side of the road. The locality is nearly surrounded by a felspathic protrusion of yellow rock, such as is frequent thereabouts.

Ballyminaun Hill is two miles and a half south-west of Gorey. There is a fossiliferous locality a quarter of a mile north of the cross-roads, on the road-side, at the edge of a greenstone protrusion.

Ballymoney Lower is on the sea coast, three miles east of Gorey. There are many beds of limestone, which are interstratified with slates and grits, all dipping at a steep angle, which are fossiliferous. Graptolites occur here.

Carrickadaggan is six miles east of New Ross, on the Wexford road-side. The fossiliferous locality is about 100 yards south of the village. A calcareous grit occurs here on the road-side, full of fossils; but the stone is very tough, and it is hard to get out the fossils. The stones in the tillage fields yield good specimens of Gasteropods and Orthides. *Lichas laxatus* was got, *Remopleurides platyceps*, *Ogygia Murchisoniæ*, *Harpes Flanagani*, *Ampyx mammillatus*, and other Trilobites; also *Echinospherites granulatus*.

Carriganeagh is 2½ miles south of Gorey. The fossiliferous locality is a few perches south-west of the school-house, on the north bank of the river.

Clogh is three miles south-west of Gorey. The fossil locality is a few perches east of the village, on the edge of an igneous protrusion.

Clologe Upper is eight miles south-west of Gorey, and 1½ miles south-west of Camolin, on the east side of the River Bann. Trilobites and other fossils are got here on the west side of a greenstone protrusion.

Coolnahinch is three miles south of Gorey. The locality is on the north side of the Owenavorragh River, close to Ballinatray Bridge, where the fossils are got.

Courtown is two miles south-east of Gorey. In cutting a deep drain, to lead water to the farm-yard, bands of limestone were quarried, which yielded fossils. They were found in the farm-yard also.

Duffcarrick is three miles east of Gorey. The rocks on the sea-shore yield fossils.

Frankfort is four miles south-east of Gorey. Five chains north of the village, there is a good locality for fossils, and there is another, to the west of this, near the plantation which bounds Ballinclay lawn.

Grahormack is seven miles south-east of Wexford, and the fossil locality is a furlong north of Tagoat village.

Kildermot is three miles east of Gorey. The townland lies on the south, at the foot of Tara Hill. This townland, Ballymoney, Seafield, and Duffcarrick, all lie along the shore, and the rocks, for two miles, are fossiliferous, making a broad zone across the strike. There are beds of limestone, interstratified with slates, in which were got corals and other fossils.

Newbawn is eight miles south-east of New Ross. The fossil locality lies to the east of Newbawn House, and on the road-side, near Collop's Well.

Seafield is three miles south-east of Gorey. There are on the shore limestone bands which yield Euomphali, and some black slates which yield Graptolites.

Shelbaggan is four miles north-east of Arthurstown. In the north end of a subdivision of this townland, called Tinnaglogh, there is a black slate which contains myriads of *Diplograpsus pristis*.

County of Wicklow.—In Glasnarget, a quarter of a mile north of Rathdrum, there is a high slaty bank, near Rathdrum Bridge, on the east side of the river, which has yielded some specimens of Brachiopoda and corals.

Slieveroe, 1½ mile north-east of Rathdrum, is a very good fossil locality. At this place a lane leads to the south off the Dublin road: along this lane, for ten chains or more, is gray fossiliferous slate. *Trinucleus ornatus* and other Tribolites are plentiful, and also Orthides. The rock, however, is not well exposed. I got fossils in slate, in the back of the road fence, and went outside into the field, where I sunk an excavation, like a grave, down to the solid slate, and was well repaid for the trouble.

At Bray Head the rocks have been called Cambrian. Sir Roderick Murchison, on seeing this place, in 1851, said, "It is the back-bone of Ireland." Whatever it may be, it contains forms like fine thread-like Fucoids, as if they grew from a centre outwards, the rays from a quarter to three-quarters of an inch long. They appear closely matted in beds of gritty slate, of from one to three inches in thickness. This has been called *Oldhamia radiata.* It occurs in five or six localities along the shore, and above the railway. The chief locality is the Periwinkle Rock, about eighty yards south-east of the first railway bridge above Bray, between high and low water. This fossil has been found also at Greystones, three miles south-east of Bray Head, also in yellowish slates on the shore, half a mile south-east of Howth. Another species, *Oldhamia antiqua,* the first of the two discovered, occurs here, but it is very scarce: it is, however, very abundant in a yellowish-gray slate on the top of Carrickmacreilly, a high hill on the north side of the road between Ashford and Rathdrum, where the slate is in apparent interstratification with thick, irregular ribs of quartz rock. Pieces of the slate are plentiful on the surface, and even spread out on the grass, full of this fossil; but, of course, by the use of a pick is the best way to get it: it is also found on the road-side, in a deep defile, which runs across this mountain about a mile south-west of Ashford. The whole number of fossils discovered in this district is 90; but it is only imperfectly examined.

Dingle.—The fifth, which I shall call the Dingle district, is in the county of Kerry. It occupies a great part of the Barony of Corkaguiny, which nearly coincides with the peninsula of Dingle. Its extent, from Ferriter's Cove, on the west, to Bartregoum, on the east, is 21 miles, and from Brandon Head, on the north, to Bull's Head, on the south, is 12 miles. In area it does not, however, on account of some indentations in the outline, realize those full dimensions. It occupies about 200 square miles.

This district has a range of coast of 60 miles, which for the most part consists of bold cliffs and uncommonly fine coast scenery. The rock is nearly all Graywacke, the great mass of it being greenish, gray, or brown, strong, hard grits, interstratified with greenish, or gray, or red, or purple slates; the grit constitutes three-fourths or more of the volume of the rock. The general strike of the graywacke rocks is S. W., and the dip S. E.

Angular pieces of dark brown, fine-grained slate, two to three inches across, are frequently seen in the brown grits of lighter colour. Rounded pebbles of white vein quartz also are usual, in both the brown and green grit; they are common in the rocks on the coast, near the mouth of Dingle Harbour. I mention this fact, because I have heard it said that the rounded white pebbles were found nowhere but in the Old Red Sandstone, which forms the basal zone of the carboniferous system. Here they are in the Graywacke.

There are in those grits and slates occasionally bands of rock, and thick bands, too, highly fossiliferous, interstratified with groups of beds of grit which are not so. Their presence, and their fossil contents, are those points of character by which the lower rocks of the peninsula, as a mass, are known undeniably to be Graywacke.

I think it convenient to begin a description of the Dingle district with a section on the west coast. There is a zone of brown, hard grit or brownstone, extending along this coast, from Sybil Point on the N., to Doon Point on the S. From the Signal Tower across the strike of this brownstone rock, to the fossiliferous band at Ferriter's Cove, is 60 chains, and this, with a dip of 65° S. E., gives a thickness of 3600 feet. This section is well exposed on the coast, but the bottom of it is not visible, being under sea level. The geological position of this brownstone is fixed by its being apparently under and conformable with the band at Ferriter's Cove, which is full of the usual fossils of the Graywacke.

This fact, of the brownstone lying apparently under the fossiliferous zone, I shall endeavour to explain presently. Ferriter's Cove is eight miles N. W., of Dingle; the rock there is generally of a gray colour, and composed of alternate beds of calcareous slate, and hard gray and some red grit. The strike, like that of the brownstone just described, is S. W., and the dip here S. E., from sixty to seventy degrees. From Doon Point, its N.W. extremity, across the strike to Clogher on the S. E., is about 4200 feet wide on the surface, which, at an average dip of 65°, gives a thickness of the fossiliferous band at Ferriter's Cove of 3800 feet. The above two items cannot be added together, as forming a part of the rocks in the section, as I shall show.

From Clogher village on the N. to Dunquin old church-yard on the S. is two miles. This part of the section in several places yields the usual fossils of the district, but it is completely broken up by dislocation. There is a greenstone protrusion on the coast at Clogher Head, near the north end of this space, and a greenstone protrusion at the south bounds of Ferriter's quarter. In the ground between those two places, and for

half a mile inland, there is a great variety in the rocks that come into juxtaposition at the surface. Although the general southern dip is preserved, the area appears to have been broken up into twenty or more blocks of rock, by faults which separate them. It is vain to attempt to calculate the thickness in these two miles of dislocated rocks with anything like accuracy. Two miles at an average southern dip of 45° would give a thickness of 7460 feet. From the greenstone protrusions and the dislocations, there is reason to believe that this calculated thickness of the fossil zone is too great, perhaps too uncertain, to be of use.

From Dunquin old church-yard to Slea Head is two miles and four-fifths, and this distance, with an average dip of 60° S., gives a thickness of above 12,700 feet of green, gray, and brown grits, interstratified with green, gray, red, and purple slates, all lying conformably over the fossil zone at Dunquin, and forming part of the same system. This is seen in the coast section from Dunquin southwards, and corroborated in the interior, between Mount Eagle and Slea Head.

The Dunquin fossiliferous band appears to be of the same kind of stone, and to contain similar fossils, as the Ferriter's Cove zone. Between those two places the lithological character of the rock is different, and so are some of the fossils. The *Halysites catenularius* is very scarce in the middle broken-up blocks, though plentiful both at Dunquin and Ferriter's Cove. Those two places might be considered either as the outcrop of a synclinal band, or the counterpart of an anticlinal, with modifications.

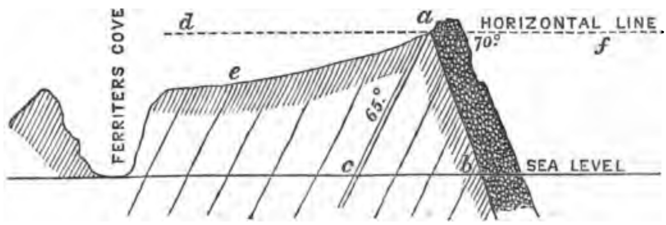
I incline to the view of an anticlinal convolution, the axis lying in or near the line from Clogher Head, by the village of Tieravane and Dunurlin old church to the shore of Smerwick Harbour at Gortadoo. To the north of this line, I think there is an overthrow of the strata, for reasons I shall give presently. To the south of it, in the steep northern escarpment of Croaghmarhin mountain, the outcrop of the rock has a southern dip along the strike, for two miles east of that mountain. The strata in the escarpment were broken off by some disruption, and separated from the counterpart, with which they were once continuous. This southern dip in Croaghmarhin soon falls into the strike and dip of the rocks south of Dunquin, in Mount Eagle, and from this the succession continues on regularly to the southern shore at Slea Head, as already stated, and there dips at a steep angle into the Atlantic.

The strata on the north side of the bay, at Ferriter's Cove, are composed of beds generally from three to twelve inches in thickness, alternately hard and soft. The hard beds are gray grit, with few fossils; the soft parts composed of beds, where the rock is sound, of perhaps half calcareous matter, being an impure argillaceous limestone. Those soft beds are worn by the action of the waves into rough grooves, and, what is most remarkable, they contain the fossil *Halysites catenularius* in the greatest profusion. Half the volume of the rock is composed of this fossil. In 1843 I brought home a flaxseed hogshead full of such fossils as the place afforded, which yielded 123 species, new and old, as read by

Mr. M'Coy, and published in the Silurian Fossils of Ireland, described by him, and printed, through Sir R. Griffith, shortly after.

To show that there has been an overthrow of the strata on the North coast of the Dingle promontory, I offer the following evidence. At Sybil Head there is a zone of strong, coarse, red conglomerate, about 100 feet thick, consisting of the bottom beds of the carboniferous system. In this zone the beds dip N. W. 70°. The brown grit it rests on dips to the S. E. about 65°. Those two rocks are therefore unconformable, but they lie in their beds *relatively* as they were when the conglomerate was deposited.

Sybil Head.



a represents the top of the cliff at Sybil Head; *ab*, the band of Old Red Sandstone conglomerate, which dips 70° N. W., and rests on the Brownstone; *ac*, the dip of the Brownstone, S. E. 65°; *daf*, a horizontal line; *ae*, the surface of the ground.

Add the dips on both sides of *a*, that is, 70 and 65 together, and take the sum from 180; the remainder is 45°, the angle *bac*. Now suppose the line *ab* horizontal, that is, in the position *af*, as it was when the conglomerate band *ab* was deposited. Since *ab*, *ac*, are relative in position, it is evident that when the line *ab* was horizontal, *ac* dipped 45° to the north; it now dips to the south. From a consideration of these circumstances it will be seen, that there must have been an overthrow of a block of the rock along the coast, which put the conglomerate, from being horizontal, to have a dip 70° N. W., as it now stands, and the brownstone, which dipped N. 45°, was capsized, taking a new dip of 65° south.

This narrow zone at Sybil Head, which comprises only the conglomeritic, or lower beds of the Old Red Sandstone, lines the coast from this to Brandon Head in a similar way, a distance of eleven miles, with about the same thickness of the rock lying unconformably on the brownstone beneath, and dipping into the ocean at a steep angle N. W. There are several detached patches of the same rock on summits and sides of hills in this promontory, of which I shall say more presently. The nearest one of those to Sybil Head is at Kinard, on the coast, three miles S. E. of Dingle, and here the beds of it are level, lying unconformably on the upturned edges of the brownstone beds. This must be assumed as the position in which those beds were deposited, and still remain so. This fact of the Old Red Sandstone beds lying level at Kinard, and

dipping 70° on the north coast, is additional evidence of a great disturbance having happened in the vicinity of Sybil Head.

This overthrow must have taken place by a depression of the rocks outside the coast in the ocean, perhaps accompanied by an uplifting of the block at the south end.

This movement appears to have extended from Brandon Head to Sybil Head, for the conglomerate band has the same N. W. dip the whole way, eleven miles, as just stated. The island of Inishtooskert, six miles to sea, appears to have been affected by the same movement and in the same way, for the two rocks, their relative positions, dips, and strikes, are all similar; and most probably also the rocks in the sea bottom, between Inishtooskert and Sybil Head. Looking from Beenaman, near Brandon Head, south-westward, affords one of the finest of the many fine views of ocean, coast, and cliff, to be seen anywhere in the promontory. Standing on the conglomerate on this bold headland, the same band of rock at Sybil Point and at Inishtooskert can be seen in the same straight line, a distance of sixteen miles.

I now turn to the condition of the rocks on the west coast, between Sybil Head and Slea Head, before the deposition of the carboniferous system. We have seen that the block of rock north of Ferriter's Cove or rather to the north of Marhin mountain, was overthrown; that, before the movement that produced that effect, the brownstone of that block dipped to the north at an angle of about 45°. It appears to me that the counterpart on the south coast at Slea Head, and to the east of it, did not partake of that movement, but that it remained unshaken. For at Kinard, three miles S. E. of Dingle, as already stated, there is a patch of the Old Red Sandstone conglomerate resting on the inferior rocks in a level position. This, I repeat, must be assumed as the position it took at the time of its deposition, and, consequently, that it remained so since. The lower rocks, near Slea Head on the south, dip south 75°. The rocks at Sybil Head did dip N. 45° before the overthrow. Here in that condition of the rocks was a great anticlinal curve; and the rocks under the vertex of the convolution appear to have been laid bare by the opening of a great rent along the axis of the anticlinal curve. Low down in that opening were the fossiliferous rocks between Ferriter's Cove and Dunquin, which were exposed by the overthrow, and remain so. Those fossiliferous rocks lie under the Slea Head group, and did lie under the Sybil Head group until the overthrow, the effect of which was to put them resting on the brownstone instead of being under it, their position in the old anticlinal. This produces the deceptive appearance of all the rocks on the coast from Sybil Head to Slea Head having a southern dip. Those to the north of the anticlinal axis, having been turned over, have now the same apparent southern dip as the rocks to the south of it which were not overthrown.

As farther evidence of the overthrow, and a break in the rocks near the axis of the convolution, I adduce the broken-off escarpment on the north face of Marhin mountain, the greenstone protrusion at Clogher Head, and the greenstone protrusion two miles south of it at Ferriter's

quarter, with the several blocks and dislocations between them already noticed. I may add, there is a low pass from Ferriter's Bay across the land to Smerwick Harbour. The physical form of the ground suggests the idea that through this pass the tides once flowed to the east and to the west alternately, and served to clear out the passage of such small fragments of rock and slate as were scattered at the bottom of the gaping chasm.

Besides the Ferriter's Cove district, fossils are got at Coosathurrig, near Bull's Head, on the coast, three miles S. E. of Dingle, in purple calcareous slate. There are also some beds of limestone of a reddish-gray colour here with fossils. The beds of rock dip S. about 70° to 80°, and the strike is very regular along this south coast from Bull's Head to Slea Head. This strike, carefully produced, would throw the Coosathurrig fossiliferous band at least a mile to the south of Slea Head. I have already shown that the rocks at Slea Head are about 12,700 feet over the fossiliferous band at Dunquin; add this mile to the above, the result is that the fossils at Coosathurrig are higher in the sequence than those at Dunquin by nearly 18,000 feet. This seems a startling statement, but the lithological character of the rocks in both localities is wholly different; the section from Dunquin to Slea Head seems persistent and unbroken, and the strike on the south coast is very regular; this being the case, it is fair to assume the conclusion as correct.

The fossils got at those two places are not of different suites, as might be expected in bands so far asunder; and as the rule, "Different fossils in different zones," would point out. All the species got at Coosathurrig are common at Ferriter's Cove and Dunquin.

Fossils have been obtained also in a black slate at Aunascall by the surveyors on the Geological Survey, but they are scarce, and no openings favourable for the discovery of fossils have ever been made in it. Aunascall is nine miles from Dingle on the Tralee road. The band of black slate stretches from Minard Bay by this village to Currycullenagh at the western face of Cahirconree mountain. It is about thirteen miles long in a N. E. direction, and one mile wide. The black slate of this place forms a peculiar band, not like any other in the peninsula. From its lying in low ground, and the cleavage at the surface, the dip is not well seen. Fossils are also got at Behernagh and at Currycullenagh, on the western slopes of Cahirconree, eight miles N. E. of Aunascall. Derrymore Glen, on the northern slope of Bartrigoum mountain, is a very good locality. This place is six miles S. W. of Tralee. Fossils from all these localities are on tablets, and labelled, in the Museum of Irish Industry at Stephen's-green, Dublin.

It has been said, by the author of Siluria (Ed. 1859, p. 188), that the Wenlock rocks, at Ferriter's Cove, are overlaid by Devonian rocks. I cannot subscribe to this view. I look upon the whole of the rocks in Mount Eagle, and thence eastward on the coast of Ventry Harbour and Dingle Harbour to Bull's Head, to be one group of red and green grits and slates, whatever they may be called: they have all a common strike and a common dip. By means of the fossils at Coosathurrig and at

Dunquin I must consider the rocks at those places, and all between them, as locked together in one inseparable group. Although no fossils have yet been found in the green and brown grits, &c., of Mount Eagle, that is no reason why they should be called Devonian rocks. What greater proof can be required of the position of a band of rock which has no fossils than to find it fixed between two fossiliferous bands which cannot be disputed? They are all three parallel, conformable, and inseparable, and would never have been considered anything else only for the theoretical error of Ferriter's Cove being considered Wenlock rocks.

Marhin Mountain, near Ferriter's Cove, is remarkable for its northern escarpment, and, as already stated, the rocks have a southern dip. Connor Hill is remarkable for a much bolder escarpment, and its rocks have also a southern dip: between those two places, which are nine miles asunder, there is no escarpment, but there is evidence of great disturbance and contortion of the strata in the line between them. After passing from Clogher Head, by the north face of Marhin Mountain, this break dips into Smerwick Harbour at Gortadoo. On the east of the harbour it emerges again, and passes half a mile south of Ballynagall, thence to Ballinloghig bridge, crosses the boundary of Dingle parish at Glin North, where it shows itself in a broken anticlinal curve, accompanied with much contortion. A little farther on, at Mullaghveal, a precipice commences, which is fully developed in the grand northern escarpment at Connor Hill, in which above 1000 feet in thickness of the outcrop of the strata is exposed, having a southern dip. In the slope descending from Connor Hill to the valley near Lough Gal, an anticlinal convolution on a large scale shows itself, and continues eastward to the road from Dingle to Castlegregory, at Clougharee, a distance of two miles. Here the anticlinal is apparently a continuation of that from the north side of Marhin mountain, the seat of the overthrow, and is distinctly visible, surmounted by the Connor Hill grits, the apparent equivalent of the Marhin and Mount Eagle grits.

At Clougharee, just mentioned, the anticlinal axis shows itself at the road side, with both a northern and southern dip; but here an overthrow similar to that at Ferriter's Cove is not apparent. It appears that the energy which produced the volcanic action and the overthrow at Ferriter's Cove was not developed here with the same power, but was confined to the simple elevation of an anticlinal axis between those two places.

From Clougharee, eastward to Lough Caum, a distance of six miles, the ground rises into a number of picturesque conical hills, in which the steep naked cliffs and deep ravines exhibit an extraordinary amount of dislocation and disturbance; but how the dislocated masses lie relatively with each other cannot be satisfactorily ascertained, as the slopes in the low country, eastward from this group, are covered over with heath and bog, and the high slopes with shingle. On the north side of the high ridge of Glenteenassig is the valley of the river of Owencashla, which falls into Tralee Bay. In this valley, is, probably, a line of fault not far from the continuation of the line of disturbance I have traced from Clogher Head by Connor Hill to Clougharee.

In my first acquaintance with this district, in 1842, I thought the fossiliferous rocks at Ferriter's Cove would be found to the east of Smerwick Harbour, in the strike produced eastward, somewhere about Brandon Mountain, but such is not the case. In 1854, I examined the east coast of that harbour, and could find only faint traces of fossils, in the place where I thought they ought to be abundant; this I try to account for thus: I have shown that there is an anticlinal convolution extending from near Clogher Head, by the north side of Marhin Mountain to Gortadoo, and this, taking a slight turn eastward, still continues to Connor Hill; that subsequently an overthrow of the strata took place at Sybil Head, to the north of this line; as a consequence of this overthrow, the fossiliferous rocks at Ferriter's Cove, which lay deep under the anticlinal axis, were laid open and exposed in this locality. To the east of Smerwick Harbour there does not appear to have been any such overthrow. Although the two rocks, Old Red Sandstone and Brownstone, on the N. coast at Ballydavid, have similar dips with these at Sybil Head, there appears to have been some circumstance that modified the overthrow to the east of Smerwick Harbour. From Ballydavid southwards towards Dingle, there is nowhere to be seen the one great rent which shows the whole overthrow together, and exposes the abundance of fossils, as it is seen at Ferriter's Cove, but the overthrow, instead of being in one place, as at Ferriter's, is divided into a number of smaller dislocations and contortions, by means of which the fossiliferous rocks, which lie very low in the sequence, as I have already shown, are not exposed, but remain covered up, partly by the broken superior masses of rock, and partly by drift, which is very thick in some places, being 40 feet on the shore at Feighanagh. This effect, though not palpable in any one place in the section, as it is on the west side of the harbour, yet on the whole amounts to about the same in the overthrow at Ballydavid Head as at Sybil Head; the modification just alluded to is probably owing to a fault running north and south in the bottom of Smerwick Harbour, already alluded to, by which the east side of the harbour was affected in a different way from the west.

It will be seen from what I have said, that there are two rocky systems in this peninsula: the older or lower is the graywacke; the upper, the carboniferous. Having described the first, I shall now say a few words about the second.

Of coal-measures in this promontory there are none; of carboniferous limestone on the high lands, none; but it occurs in the Magharee Islands, in Tralee Bay, and the shores of the small bays to the north of it; there is a little on the south shore of the same bay, at the church of Camp. But of the basal beds of the Old Red Sandstone, there are remains in several patches, often on the tops of the hills, every one of which lies unconformably on the lower graywacke, and in those patches, among themselves, the planes of the bedding do not coincide in inclination.

1. As I take those in order, the first, at Sybil Head, has been partially described, but along with Sybil Head may be grouped other patches

detached from each other, by indentations on the coast, but all in the same line, and having the same dip to the N. W. Those are the Three Sisters, west of the mouth of Smerwick Harbour; Ballydavid Head, to the east of it; Beenaman, near Brandon Mountain; and Brandon Head itself, part of that mountain.

All this group, as already alluded to, together with Inishtooskert, an island six miles seaward, in the same line, have the same strike, and all dip N. W.

2. The second patch of Sandstone, already alluded to, is at Kinard, three miles south-east of Dingle; it stands at about 600 feet above the sea. The beds here lie nearly level, and the whole thing forms a cap on the hill, about a mile and a quarter long, in a N. E. direction, and a quarter of a mile wide, of oval form. This locality affords a clear proof that the Brownstone and the Old Red Sandstone are of two different ages in the history of the earth. There is a manifest unconformability existing between the lower brown rock, whish dips S. 70° to 80°, and the upper red soft sandstone, which lies in beds nearly level on the upturned edges of the former. This unconformability points out the true line of demarcation between the two systems, although both are red sandstone, differing, however, in this circumstance, that the lower, besides the characteristic fossils of the Graywacke, at Coosathurrig, close to this place, is more brown, and very hard; the upper, more red and soft, and without fossils.

The Old Red Sandstone at Kinard may have an extension into the adjoining townland on the east; the flat land of it is for the most part covered with large boulders of red conglomerate and blocks of red sandstone, but I could not see any of this rock in situ, even in the high land, and boulders are no proof that the rock beneath them is of the same kind. The rocks near this, along the coast, from Bull's Head, are of the usual Graywacke type.

3. The third patch of Old Red Sandstone extends in an easterly direction from a point a quarter of a mile south of the western of the three Coumanare Lakes, or about two miles S. E. of Connor Hill, to Lough Slatt, a distance of six miles, but it is of unequal breath, from half a mile to a mile. It covers unconformably the tops of a range of hills, that extends from the north brow of Bartregoum, westward to Connor Hill. The conglomerate at this place stands at from 1500 to 1700 feet high, and the three lakes lie in a synclinal hollow to the north of the Old Red.

At the east end of this piece of Old Red Sandstone, immediately close to Lough Slatt, there is a precipice called Foylenagreave, above a hundred feet high, in which the conglomerate appears to be about sixty feet thick. The beds dip N. W. 25°, overlying at this place a brown, micaceous, flaggy grit, which dips N. W. 60° here; both dips are N. W. but the difference of the angle proves that the two systems are unconformable, as well as if they dipped in different directions.

4. The fourth is a cap of the conglomerate on the Hill of Doon, half a mile S. E. of Lough Slatt, which appears about sixty feet thick. It is

a quarter of a mile in diameter; it stands at 1500 feet high; it dips N. about 30°, resting on thick, strong, green grit beds, visible in the next stream eastwards, where they dip W. 60°.

5. The fifth is another detached mass of this upper rock, on the summit of Cummeen Hill, half a mile east of Doon; here, as at Doon, the plane of the bottom of the mass dips N. 30°, and lies unconformably on green grits and slates, dipping W. 60°. This hill is 1500 feet high.

6. The sixth detached spot of Old Red Conglomerate is at Hillville, four miles W. of Castlegregory, forming a cap on the Graywacke there also, in extent about a square mile. The hill is about 200 feet high, and the dip of the conglomerate 20° N.

7. The seventh is at Brandon Point. At this place the steep dip ceases on the north coast. The rock appears to rest in its original natural condition, on the underlying green and purple grits, and descends gradually to the shore at Brandon Bay.

8. The eighth locality I shall notice is at Scrallaghbeg, a mile south of the church at Camp, on the road-side, and ten miles from Tralee. The Old Red of this place is evidently of the lower beds, and a continuation of the detached masses described as the third, fourth, and fifth patches.

The outcrop at this place is traceable on the northern slope of Bartregoum Mountain, for three miles eastward, where it turns southward, covering over the summit of the mountain, and descends on the south side. From this summit eastward the whole of this dome-shaped mountain is covered both on the ridge, and the north and south slopes, with this rock. From Bartregoum, the highest point, which is 2796 feet high, the ridge slopes down gradually to the east, for twelve miles, till it comes near the mail-coach road at Currens, where it is succeeded conformably by calciferous slate, containing a profusion of the ordinary fossils of the Carboniferous limestone. This is one of the best localities in Ireland for those fossils. It is covered by the limestone about Castle Island, and that surmounted by the coal shales of the Munster coal district. A good junction of these rocks is seen at Cordell, three miles east of Castle Island.

In the following little Table is a more concentrated list of the several patches of Old Red Sandstone in the Dingle district. The first column is the name of the townland, or the name of the particular hill, where this rock occurs. The second column is the height over the level of the sea of the top of such hill or townland. The third shows the dip and direction of the Graywacke in the hill or mountain mass which underlies the Old Red Conglomerate. The fourth column shows the dip and direction of the Old Red Conglomerate itself, as it rests in its place on the hill or townland. The strike of the rock in the two latter cases is always, of course, at right angles to the dip.

This Table shows two interesting facts:—The first is, that, taking the strike and dip of the Graywacke in the vicinity of the patches of Old Red Sandstone, and comparing them with the strike and dip of the overlying Old Red Sandstone, the two rocks are not at any point conformable; and this physical unconformability is not only the case in the

Dingle peninsula, but also in above seventy cases* which I observed in the northern counties of Ireland, in the midland counties, and in the south.

Secondly, in the Old Red Sandstone itself there is a considerable difference in the dips of the several patches, showing that, for the most part, those several blocks of the earth's crust on which the Old Red has been deposited have been thrown by disruption and dislocation into different positions from what they were when the first layer of the Old Red Conglomerate was laid down, which we must assume to have been continuous and horizontal. By the change in the planes of the bases of those patches, as designated by the dips, it is seen that they have taken those different planes of inclination from the original position. From the different heights it is seen that some blocks have been thrown up, and some thrown down, thus some of them taking heights different from others. The summit of Bartregoum, on Old Red Sandstone, is 2796 feet above sea level, and the rock horizontal; while at Sybil Head the same rock and the same bed dives into the ocean, at an angle of 70°, to an unknown depth. Those variations visible in the district, with all the intervening heights and inclinations at which the patches rest, show dislocation to a great amount.

Name of Locality.	Height.	Graywacke dip.	Old Red Sandstone dip.
Sybil Head, 8 miles N. W. of Dingle,	About 600	S. E. 65°	N. W. 70°
Kinard, 3 miles S. E. of Dingle, . .	About 500	S. 70	level
Coumanare, extends from 5 to 10 miles; long. N. E. by E. of Dingle, . . .	2000	S. E. 35	N. 20
Doon, 4 miles S. of Castlegregory, .	1199	N. W. 70	N. 35
Cummeen, 4 miles S. of Castlegregory,	1577	N. W. 70	N. 35
Hillville, 5 miles W. of Castlegregory,	About 200	N. W. 80	N. 30
Brandon Bay, W. side, ...	shore	Invisible	S. E. 20
Scrallaghbeg, 5 miles S. E. of Castlegregory, ...	600	S. 75	N. 50
Inch, 7 miles S. of Castlegregory, . .	About 300	?	S. 40
Bartregoum, 7 miles S. W. of Tralee, (summit), ...	2796	?	level

One of the many interesting circumstances to be seen by a geologist in this promontory is the marvellous amount of denudation that has taken place in it. The carboniferous system, which overlies the Graywacke in the south of Ireland, is very extensive. It occupies the country from Galway Bay, on the north, to the River Blackwater, at Mallow, on the south, and from the Atlantic Ocean, on the west, to Kildare and Carlow, on the east. To the south of the parallel of Galway it covers above 10,000 square miles, and this is less than half its area in Ireland. The Old Red Sandstone averages 1000 feet in thickness. The mountain

* Journal of the Geological Society of Dublin, vol. vii., p. 119.

limestone is about 1400 or 1500 feet thick at Black Head, in Clare, to the south of Galway Bay, and the coal shales and sandstones may be twice as much on the west coast of Clare—in all about 5500 feet. I mention this to show that Nature treated us liberally to some of the carboniferous rocks, especially limestone, which in other parts of Great Britain is under 100 feet.

To the south of Tralee the dome-shaped mountain of Slievemish is covered over with Old Red Sandstone, the lowest division of the carboniferous system. Farther south, in the valley of Kilorglin, is seen the limestone and the coal shales. Here the whole system is developed. The same succession occurs to the north of Tralee Bay, and, on a grand scale, to the east of that town, towards Kanturk; but on the western part of the Dingle promontory, what a small remnant of it is now left, where there is every reason to suppose that the system, in its full development, once existed over it all! Now all the coal shales are gone, all the limestone gone, all the Old Red Sandstone gone, except the few patches of the lowest beds of it, which I have noted, and which might be called the antiquities of the Old Red Sandstone. All this done by some tremendous agency, that we cannot form even a conception of. We can only look up with astonishment at the wonderful power that achieved it all.

I have shown that there is an overthrow of the strata of Sybil Head. From the dip of the conglomerate there, and the similar dip eastwards, it would naturally be inferred that whatever movement affected the rocks at Sybil Head would have affected them all along on the north coast. It is a question whether this is the case or not. I think not, for the following reasons:—

The old red conglomerate at Sybil Head lies on a certain block of brown rock, and is attached to it immovably. It dips N. W. 70°, and forms a skirting along the coast. The dip is the same at Ballydavid Head, east of Smerwick Harbour. Further east, at Beenaman, the dip of the same zone changes to 50° N. W., and this is persistent on Beenaman and Brandon Head. At Deelick, to the east of Brandon Head, the dip of the same conglomerate is from 30° to 20° at Brandon Bay.

Those changes of the dip of the Old Red Sandstone zone on the coast suggest the idea that each block or division to which the conglomerate, with a different dip, is attached, has been differently affected by the movement which has caused the overthrow at Sybil Head.

To show this a little more in detail:—The old red conglomerate on the N. W. border suggests the idea that this coast, and the country to the south for a few miles, should be divided into three parts, by lines nearly at right angles to the coast. 1. From Sybil Point to Coosaunacunna, near Tiduff, a distance of seven miles. This division embraces Sybil Head, the Three Sisters, and Ballydavid Head; and, although the mouth of Smerwick Harbour and other gaps break off the continuity of the conglomerate, its base is in the same straight line, and it dips at the same angle (70°) all the way. 2. The second division extends from Coosaunacunna to a large creek, where a slip took place at the eastern

boundary of the townland of Araglen. This embraces the headlands of Beenaman and Brandon Head, and occupies four and a half miles of the coast. The conglomerate zone is still persistent, skirting the ocean, and it dips into it in this division at about 50° N. W.

The line which separates the two divisions just pointed out, as appears to me, would be found somewhere between Ballydavid Head, where the dip is 70°, and Beenaman, where it is 50°. Between those two headlands a long, narrow slice of the coast appears to have slipped away into the deep, carrying with it brownstone, conglomerate, and all. There are three or four other similar indentations on the coast, but in every case the base of the conglomerate on both sides of the gap, continues in the same straight line. It is in this, the largest of those gaps, that the line of disruption alluded to begins. From Coosaunacunna Creek it proceeds southwards, near the line of the road, to Ballybrack Bridge, and on to Ballycaneen Bridge, and from that place lies in or near the line of the river till it enters Dingle Harbour near the town.

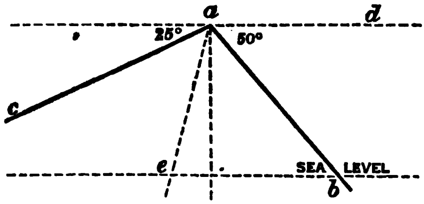
3. The third division extends from the creek at Araglin, by Deelick shore, to Brandon Point, three miles. Here a change takes place. The conglomerate zone is not confined to a skirting along the coast; it turns inland to the east of Araglin Creek for some miles, and covers the whole of the Graywacke rocks on the low eastern slope of Brandon Mountain down to the shores of the bay. There is no overthrow in this division. The dip on the north coast lessens to 30°, and gets still lower towards Brandon Point.

The line which divides the second from the third of the divisions appears to run from the Araglin Creek nearly straight to the village of Cloghane. This shows the whole of the third division, as covered with Old Red Sandstone.

I fix on these lines of disruption in a rude way at right angles to the coast, and lines of the same kind, nearly parallel to them, may be presumed to pass, one through the bottom of Smerwick Harbour, and along the low ground, southward to Ventry Harbour; another line, of more evident disruption, runs along the rough crest of the ridge, extending from Brandon Hill southwards towards Connor Hill. This crest is so steep and broken on the east side as to show that a great slip took place along this line, by which the country to the east of it sunk down 2000 feet more than the country to the west. This is shown at Lough Cruttia, which is 638 feet above the sea, while the trigonometrical point in the ridge opposite to it on the west, three-quarters of a mile off, is 2764 feet high, by the Ordnance maps. This great difference of elevation in so short a distance might exist without a slip, if the crest were formed by an anticlinal axis; but it is not so. The general E. N. E. strike of the beds across the ridge puts such a case out of the question. The same beds that are at the summit appear to have been thrown down to the east by a slip to Lough Cruttia, or somewhere very near it.

I now proceed to try if the brownstone, which underlies the Old Red Sandstone conglomerate at Beenaman, to the east of Smerwick Harbour, has suffered an overthrow like that at Sybil Head. The con-

glomerate at Beenaman, as already stated, dips N. W. 50°. The inferior Graywacke, or brown grit, dips S. 25°. Let *ab* represent the slope of the conglomerate, dipping at an angle of 50° from the horizon; and



ac the dip of the brown grit, in the opposite direction, at 25°: it is evident the angle *bac* = 105°. Now, suppose the line *ab* in a horizontal position, coinciding with *ad* (as we must assume the conglomerate was when deposited), then line *ae* will be the position of *ac*, the southern dip, and that dip now 75°, which was the condition of the brown grit when the conglomerate was laid down. This does not amount to an overthrow of the strata at Beenaman, as it does at Sybil Head; only a change in the dips—the conglomerate, from being level, to 50° N., and the brown grit from 75° to 25° south.

It has been said that the fossils obtained at Ferriter's Cove are Wenlock fossils. The physical aspect of this subject affords another and a different view of the case, and, to show this, I must repeat some of what I have already stated. The fossiliferous zone at Ferriter's Cove I believe to be the anticlinal counterpart of that at Dunquin. This latter is surmounted conformably to the south by alternating grits and slates, of all the usual colours, 12,700 feet thick, through Mount Eagle to Slea Head, where the upper beds dip at a high angle into the ocean. It is unknown how much more may be over them, but most probably a mile, or 5000 feet at least, calculating it up to the produced strike of the grit beds at Kinard. There is thus 17,500, or, say, 18,000 feet thick of Graywacke over the fossiliferous zone at Dunquin. Here is a great difference. The Wenlock limestone is 2800 feet below the top of the series in the original Silurian country; the Ferriter's Cove fossils are 18,000 feet, and more, below the top; those zones, therefore, cannot be equivalents physically; they occupy positions far asunder in the sequence. The Ferriter's Cove zone is, in reality, miles lower down, although there are some species of the fossils similar in both. We find them in the lowest visible part of the district, that is, in the very gorge of the overthrow.

The following is a list of townlands in the vicinity of Clogher Head, where fossils have been obtained, this being the locality where the top of the old convolution, or axis, exists, forming the boundary of the block of country which was overthrown to the north, now Sybil Head, the Three Sisters, &c. This axis is nearly in a straight line from Clogher Head, by the northern escarpment of Marhin Mountain, to Gortadoo,

where the line enters Smerwick Harbour. The list is taken from north to south, as the townlands appear on the Ordnance maps:—

Ballyoughteragh South, or Ferriter's Cove.	Ballinahow Commons.
Smerwick.	Glanmore.
Gortadoo.	Glanlick.
Ballyaglisha.	Ballintemple.
Ballincolla.	Vicarstown.
Tieravane.	Ballinaraha North, or Dunquin.
Clogher.	Ballylickeen Commons.
Graigue.	Ballinglanna.
Ferriter's Quarter.	Glebe.
Ballinahow.	Commons North.

The fossils discovered in the Ferriter's Cove district and Coosathurrig are 120.

OBSERVATIONS.

The Silurian System of Sir R. I. Murchison has been hitherto the standard by which a fossiliferous Graywacke district in one country has been compared with one in another. It is by it we compare English with Irish districts, and Irish districts with one another. Many are the cases, however, in which there is but little likeness between the leading features of one district and those of another.

We are familiar in Ireland with the carboniferous formation, and know it by three divisions—the Old Red Sandstone, the Mountain Limestone, and the Coal Series—all so distinct in the kind and the colour that any one of them can be recognised at a glance of the eye, without minute examination. The Old Red Sandstone, the lower band of the three, is red and sandy; the limestone is bluish gray, of various shades; and in the coal series the shales are black, and the interlaminated sandstones white, yellow, or gray. On the other hand, the Graywacke, which is the Silurian on the great scale, is by no means so easily recognised in its subdivisions. The general gray colour is almost constant, in the north of Ireland, in both the slates and interstratified grits. In the south the type is not the same: the grits are greenish or brown; the slates are gray, green, red, or purple. All those varieties of grits and slates are frequently repeated, and the bands mostly narrow. In fact, our Graywacke rocks have no constant type, and especially the fossiliferous zones of them. The Tyrone district has but few features in common with Galway; the Kildare and Dublin are different from either; the Wexford has a resemblance to the unexplored counties of Ulster, but unlike Tyrone, Galway, or Dublin; and the Kerry and Cork district, in the detail of the beds, lithological character, and other particulars, is very different from all or any of the other four.

As I proceed, I shall make a few quotations occasionally from the Silurian System of Sir Roderick I. Murchison as headings for my subject. He says at p. 195, in speaking of the value of his labours—"To comprehend the extent of the break in the history of the older strata which

has been filled up by the study and classification of these rocks, the student has only to refer to the tabular view I have prepared, and compare it with other tables framed upon an antecedent state of geological knowledge. He will then perceive that what is here presented to him as a well-ordered succession of great thickness (each subdivision of rocks being characterized by a corresponding suite of organic remains), was formerly considered one assemblage, without definite sequence, and included under the unmeaning terms, Graywacke, or transition limestone."

Again, at p. 195, he says:—"Acting upon the principle which guided William Smith in subdividing the Oolitic system of our island, I have named these rocks from places in England and Wales, where their succession and age are best proved by order of superposition and embedded organic remains, and have termed them, in descending order, the 'Ludlow, Wenlock, Caradoc, Llandilo,' and the general term, 'Silurian System,' for the group, to mark thereby the territory in which the best types and the clearest relations are exhibited."

It appears to me that what was believed by the author to be a well-ordered succession, each subdivision of the rocks being characterized by a corresponding suite of organic remains, must be put back again, as he found it, into one assemblage, without definite sequence, and included under the term Graywacke; because the subdivisions he made are not each characterized by a corresponding suite of fossils, as stated, and the principle which guided William Smith, in subdividing the Oölitic system of England, does not apply to those older rocks, as I shall show.

I never could make the table of seven columns, referred to in the foregoing quotation, and printed in the Silurian System, pp. 540 to 550, agree with the views I entertain from studying the Irish fossiliferous districts. The last table of seven columns, put into Siluria, 1859, though different from the first, appears to be no better. By those tables, and the two foregoing quotations, the world is led to believe that the Graywacke formation is made by Nature into seven definite fossiliferous zones, founded on superposition, and that each zone contains a group of fossils peculiar to itself. This I think an error, and, as a practical geologist, I protest against it. There are no such seven zones to be found in any one locality, nor in any one known natural sequence of those old rocks, so far as I know or could ever learn.

In the foregoing account of Cunemarra I have given a list of the fossiliferous localities, their descriptions, and a catalogue of the fossils obtained in each of them, to show that in that country neither the lithological character of a band of rock, nor the fossiliferous contents of the same, are persistent for any great distance, and that it appears to be of little use to found a system of zones on the fossils, since all those varieties may be found in one zone.

Only for the brownstone band, which I take to be an indisputable index in Cunemarra, I might form a system of columns, and fill them up from each locality, as the table of the Silurian System appears to me to have been filled. Every locality would make a fair variety for one column. There would be Corals in one or two; Gasteropods would pre-

vail in one; Brachiopods in two or three, with Cephalopods and Trilobites; but, unfortunately for this scheme, the brownstone basal band is a stumbling-block. I am bound down. I cannot give rein to my Pegasus, for those different varieties of rock and different groups of fossils all belong to different localities in one fossiliferous zone, a few hundred feet in thickness, and are of one age.

The author says, p. 209:—"The Wenlock limestone is, in every respect, identical with the well-known rock of Dudley, and contains the same organic remains. Here, however, it exhibits relations to the superior and inferior strata, which do not exist at Dudley; and hence the name of 'Wenlock' has been preferred."

In making out the table given in the original Silurian System, the district from Wenlock to Aymestry was carefully examined, and its contents recorded. Had it been left so it would have been very well. But this was not enough. Dudley, twenty-three miles away, a locality fertile in fossils, was brought in to swell the lists of the upper Silurian zones. So was Horeb Chapel and Felindre, near Llandilo, sixty miles away on the other side, and recently Benson Knot and Brigsteer, localities in Westmoreland, 120 miles away. Was it right to apply the fossils of these localities in this manner? I think not. I shall try their merits, and see the claims they have, that those fossils should be put into the Upper Silurian groups.

In examining this subject, I found that scores of the fossils, put into the Upper Silurian divisions by the author, have been also found in the Lower Silurian zones in other parts of Great Britain, and in Ireland. This put me upon a plan of making out some test by which I could know whether a fossil belonged to the Upper or the Lower, for the custom now is, on getting a parcel of strange fossils from a Silurian district, to ascertain whether they are from an Upper Silurian zone, or a Lower.

I first copied the table in the Silurian System, putting the fossils of the seven columns into two, upper and lower.

In doing this I found that half the old names were since altered, and that there are now about two and a half times as many fossils known as there were 1839, when the Silurian System was published. To show how many of the former upper fossils are now got in lower zones, I must have a new table, and that may as well be made fully up to the present time as not. The table will be more useful, and the introduction of the newly discovered fossils into it will not interfere with the main object for which it is intended.

Last spring (1859) a new edition of Siluria appeared, and that contains a list very nearly what I wanted. The most recent and improved nomenclature is adopted in that list, made out by Mr. Salter and Mr. Morris, two of the best authorities in Great Britain on this subject, and it appears that nothing was left undone by them to bring it as near to perfection as they could. This part of the subject has become complicated and puzzling latterly by palæontologists, who altered the names of fossils much the same as if they turned ducks into geese, or goats into sheep. To such an extent has this been carried, that some species have

got five or ten or fifteen names. *Halysites catenularius* has twenty-seven different names.—Edw. Brit. Cor., p. 270. The new list in Siluria, 1859, has been well considered, and it is to be hoped the names may hereafter be allowed to stand. Many of the old names are put into more correct genera; many of them rejected altogether, as bearing other names of earlier date. What gives great confidence to geologists in this list, is the care bestowed upon it by those gentlemen. Salter gave up many of the old names he had given to fossils himself, or adopted formerly; and Morris has given up so many of the old names in his Catalogue, that, when a new edition appears, it will scarcely be known without an ample explanation.

In making out my new table, I found it necessary to put it into columns, and make it in this way into four principal divisions, not as zones of superposition, but as evidence.

1. The fossils of the original Silurian System, in two columns, upper and lower.

2. The fossils found by Phillips in South Wales. Those I also put into two columns or subdivisions, upper and lower; or, as he has it, east and west.

3. The third is from the British Palæozoic fossils in the Cambridge Museum, as recorded by Professor M'Coy, upper and lower.

4. The fourth is all from Ireland; chiefly from M'Coy's Silurian Fossils of Ireland. In this division I have marked five columns or subdivisions for the five Irish districts in which fossiliferous localities have been discovered, all of which I believe to be equivalent to the Lower Silurian. I shall make a few observations upon the authorities on which those four divisions are founded.

1. The first division is from the original Silurian System, which, instead of seven columns, occupies only two, one for the upper, and one for the lower Silurian fossils; those being the two great divisions which the author took much pains to establish. This division of the table shows, whether in the upper or the lower, every fossil of this formation, known in 1839, nearly all of which he discovered and collected himself, I believe, with his own hammers and bags.

2. The second division of the table is taken from the "Memoirs of the Geological Survey of Great Britain." Professor Phillips was intrusted with the management of the part of this survey which is in South Wales. He thought there was reason to believe that the eastern part of South Wales belonged to the upper group of the graywacke formation, and that the western region was the lower. He says, Mem. Geol. Surv., ii. 217:—"The western part of South Wales contains types of stratification, and suites of fossils analogous in many respects to those of North Wales; the region of Malvern, Woolhope, &c., corresponds still more exactly with the Salopian series, already described as the Silurian type by Sir R. I. Murchison. In many respects the eastern district deserves this distinction; for here principally the calcareous element of the series is developed, and with it a variety of organisms, which are elsewhere absent, or of rare occurrence."

"In a general sense the whole series of strata in the district from St. Bride's Bay to a point east of Caermarthen may be regarded as Lower Silurian."—p. 220.

Of Goldengrove, near Llandilo, he says (p. 221):—"In a general sense this series may be regarded as containing peculiar types, both of Upper and Lower Silurian, which cannot be clearly understood, or placed in just comparison with the other districts till we have taken the evidence of organic remains."

These quotations show that Professor Phillips considers the eastern region of South Wales Upper, and the western region Lower Silurian.

He selected six principal localities in the eastern or upper region, and six other localities in the western or lower, and he tabulated all the fossils he found in the two regions in classes, to show what kind of animals prevailed in the upper, and what kinds prevailed below. In carrying out this arrangement, he gives all the localities where he found a particular fossil, and not only that, but even the number of specimens found in any one locality. There appears never to have been any inquiry carried on with a greater regard to philosophic truth than was evinced in this examination, and the results are, of course, most trustworthy. I have placed those results in apposition with Sir Roderick Murchison's results in the Silurian System; and, on comparing the two, some unexpected differences may be seen.

In the columns of this division, instead of stars, as put to show in the others where a fossil occurs, I have put figures. The figure 4, for instance, in the lower column, shows that the particular fossil was found in four of the western or lower localities of South Wales, and so on.

Professor Phillips, though he got many new fossils, did not find all the fossils of the Silurian System previously known in that part of South Wales which he examined: many were wanting; but he set down only what he saw. Neither are the names he gives all to be found in Morris's Catalogue; but, when other names appear, every fossil he records, if not new, is placed in Morris and in Murchison under some other name. The whole number of species he found was 353.

3. The third division of the table has two columns, also for Upper and Lower. It is chiefly taken from the "British Palæozoic Fossils" collected by Professor Sedgwick, and described by Professor M'Coy; some, however, are from the "Annals of Natural History," some from the Quarterly Journal of the Geological Society, some from the Palæontological Society's works, and some from a few other sources. The fossils from the latter authorities are generally new. I must say that this division of the table has not my entire confidence as to upper and lower zones. Palæontologists appear to have been led by the fossils as to what districts were made Upper or Lower, following the Silurian System. Benson Knot, near Kendal, was made the equivalent of Dudley, and Dudley the equivalent of Wenlock, without any physical connexion ever having been traced between them, or a shadow of proof by superposition. Notwithstanding this, the third column deserves a place, from the well-known position of many of the localities, and from the integrity with which the locali-

ties have been recorded. Professor Sedgwick, through Mr. M'Coy, in the British Palæozoic Fossils, page 25, has given forty-eight localities for *Stenopora fibrosa*. Even if the theoretical interpretation of the zone be wrong, the locality is right.

4. The fourth division is exclusively Irish. It is chiefly made out from M'Coy's "Silurian Fossils of Ireland." This division is different from the others, which have two subdivisions each for Upper and Lower. This has five columns for the five fossiliferous districts of Ireland, one for each.

It may be asked, and it has been asked already, why should any one now try to disturb the Silurian System, which has been universally adopted in England for the last twenty years. To this any philosopher will reply, that the sooner any erroneous system is abolished, the better for science. The author promulgated his views. There was no one who took the trouble to investigate his statements, or to analyze his table. At that time, in reality, there were no data to controvert them; all was taken at his word. What are all the geologists and palæontologists of Great Britain, but persons who got their geological education in the Silurian System, or adopted it? Silurian students are likely to exercise the craft they learned, and no other. It cannot be expected that educational prejudices can be easily set aside. All the geologists of England are, therefore, in favour of the Silurian System. Werner had geology all his own way for years; then Hutton started with other views, and all Europe knows the result. The Silurian System carries all its own way at present; how long it may do so, remains to be determined.

Professor Phillips, in his Anniversary Address, 1859, page 61, in speaking of differences of opinion on geological subjects says:—"On some of those weighty subjects we are not all entirely agreed; on others we have not even laid securely the basis of a lasting agreement. Let us not regret this want of unity, nor stifle under forms of general acquiescence the real differences of interpretation to which unlike phenomena and unequal opportunities of study ought to conduct us. The theory of geology is nothing less than the physical history of the globe, and this history is to be extorted from the archives of Nature by question upon question after doubt upon doubt. When geologists cease to inquire; when a dogma is quoted to relieve a doubt; when faith in the dictum of some favourite author outweighs the evidence in the book of nature, we may indeed have much of form in our geology, but little of truth or energy."

My experience in geological research in Ireland, which now is of above forty years' standing, leads me, and, I believe, would lead any one in similar circumstances, to have very little faith in the "Silurian System." The universal application of the fossils found in its zones for the identification of supposed similar zones in other distant districts or countries, has not stood the test of time and discovery. It was useful as a temporary expedient, even though untrue in principle, to set men on one great road to knowledge, and continue on that road till its faults became known, or till a better one was discovered; something like cer-

tain questions in arithmetic, which, by assuming any false number, and working it out on given conditions, the truth may be arrived at.

I am fully satisfied that if the author of the "Silurian System" had had the chance to study the Cunemarra rocks and fossils before the Silurian System was written, his Silurian table of fossils would have assumed another form. Cunemarra, where the bottom of the system is clearly visible, would never have suggested a division of the Graywacke into seven zones. The name "Silurian" would in Ireland, on the principle of nomenclature he adopted, probably have been "Milesian."

On examination of the rocks between the Severn, near Coalbrookdale and Aymestry, the succession was made by the author into two divisions, Upper and Lower Silurian. Taking in a few of the adjacent localities, the whole was divided into seven zones. Those zones are now set up as a model for the whole world. In applying the Silurian district in this way, it should be remembered that it is but a small and a peculiar one,—a mere spot on the map of Europe. It is twenty miles long, and three to four wide, about seventy square miles. The Graywacke district of Waterford, Wexford, and Wicklow, occupies 1850 square miles, including the marl, which covers some of it. This district is further peculiar, because it has three parallel bands of limestone, near each other. It is peculiar, because those bands are fugitive, and die out southward in twenty miles, and are, therefore, not likely to extend under ground to Dudley across the strike. It is peculiar, because those limestone bands produce corals, which are not found in sandy or muddy deposits; and, finally, it is peculiar, because there is no physical equivalent for it known in the British islands, nor as yet in any part of the world. Sir Roderick, as a philosopher, perhaps should not, under such circumstances, have set up a small and peculiar district, as a model to guide all nations in geology, and overlook districts which are more extensive and more generally like each other.

If the fossils got between Coalbrookdale and Aymestry, the original Silurian district, had been kept together in one group, and faithfully recorded as Upper or Lower Silurian, as the case might be, it would have been worthy of credit, as a definite thing, and useful to science. When we find that any zone, or column, say the Wenlock, does not actually contain the fossils found in the original Wenlock limestone, or shale bands, but has been tampered with, and the fossils of other distant zones introduced into it, it is then a bad zone for Geology, for Paleontology, or for Philosophy. When the fossils of Dudley and Horeb Chapel were put into the Wenlock column, the fossil zone represented by that column was deprived of its integrity, and made into a sham.

In the new edition of "Siluria," 1859, the table differs from the old one of 1835; but in this, like the first, localities detached and distant are clubbed with one another, and two or more of them made into one zone. The Tyrone fossils are put into the Caradoc column, along with those of Kildare, Dublin, Waterford, and Wexford. Galway is put into the Llandovery rocks, and Kerry is put into the Wenlock zone. Siluria,

Ed., 1854, p. 171. The whole sequence of the zones of the Graywacke, as the author interpreted them, appears to have been put into confusion by this transposition, and the whole table vitiated when thus deprived of its integrity.

I know the Irish districts; and, no matter what a palæontologist, or a system-making geologist may say, I know that in Cunemarra is exposed the lowest part of the Graywacke in Ireland. There is nothing more obvious in all nature than that Graywacke lies there unconformably on mica slate. Any one who, in order to support a theory, says that mica slate is not an older rock in Galway, but the same Graywacke altered by metamorphic action, appears to me to be going too far in support of any theory.

The author says, Siluria, 1859, p. 531: "In the column, Llandovery rocks, both the upper and lower divisions are united, as they form one natural history division." Into this column he has put the Galway fossils, as already stated. There ought to have been some further explanation of this. How do the upper and lower divisions form one natural history division? What is a natural history division? The explanation given seems a misty one. If the Galway fossils, according to his views, partake of a mixed character, it was he that mixed them. He made an artificial test, by which he compared them, and he could not get them to fall in with his test, in either the upper or the lower. The great Almighty made the Galway zone; the author of Siluria made the Llandovery column. By the one, the Galway series of rocks and fossils were placed in His foundation; the other put them in the fourth story of his fabric.

As for Kerry, I have shown that there are 13,000 feet in thickness of grits and slates in Mount Eagle, lying conformably over the fossiliferous band at Dunquin, and this appears to me a weighty reason for keeping it below. If Aymestry and Wenlock be in the upper zone of the Graywacke, Cunemarra and Dingle are not. The original Silurian country cannot be made an equivalent similar to any of our Irish districts, whatever conclusions may be drawn from a handful of fossils. Let no man put above what the Great Maker has put below.

The practice of distinguishing groups of Silurian strata in England does not appear to apply in Ireland. We have here no such bands of limestone and shale as those of Wenlock, Ludlow, and Aymestry. The western groups of South Wales, and that of Llandovery, resemble the fossiliferous districts of Ireland more. The same observations, I believe, apply to North Wales, to Scotland, and to Westmoreland; I might add, perhaps, America. The author himself says emphatically that in Russia "There is no succession of the rocks to be found like that near Ludlow."—Quarterly Jour. Geol. Soc., xv., 416. And again: "I ascertained that in Bohemia, Scandinavia, and Russia the chief inferior zone of primeval life was essentially the Lower Silurian of Britain."—Siluria, p. 10. In those quotations the author goes even farther in support of my views than I had opportunity to go myself.

In speaking of the Tyrone district, I have made some comparisons,

which would lead to the inference that the so-called Old Red Sandstone of Herefordshire and the Brownstone of Tyrone are equivalents. I have seen both, and I believe they are. This Old Red Sandstone overlies the upper Silurian rocks of Wenlock and Aymestry, conformably; the brownstone of Tyrone overlies the fossiliferous rocks at Lisbellaw and at Pomeroy conformably. What is the conclusion to be drawn from these facts? That the rocks about Ludlow and the rocks about Lisbellaw are equivalents, both being covered conformably by the brown groups, seven or eight thousand feet in thickness, and in exactly similar positions as to succession. If Ludlow and Wenlock be in the upper part of the graywacke, so are Lisbellaw and Pomeroy.

I know that this view of the graywacke of Tyrone, with its fossils, being put as the upper part of that group, will be cried down with a loud and long cry. What do I care for such cries? I surveyed and examined this district geologically, and ought to know it better than any man who never saw it, and in this case who undertakes to give it a position in the sequence by its fossils, according as he found fossils in another district many hundreds of miles away. I think no man has a right to interpret the works of Nature in this loose way. I do not care for the assertion that the Tyrone fossils are lower Silurian, because with my eyes open I see they are in the uppermost part of the fosiliferous Graywacke.

In South Wales, Professor Phillips has put all to the west of Llandilo into his western or lower Silurian district. The author of the Silurian System has put the same localities into his upper Silurian group. This is a difference. It may be useful to select a few of the descriptions of the upper Ludlow rocks, as they are given in the original Silurian System, with a view to explain it.

1. By the section given in the Silurian System at p. 196, and the accompanying letter-press, it appears, as already stated, that the original typical Silurian district has the outcrops of three parallel bands of limestone, alternating with bands of shale. Two of those are called the Aymestry and Wenlock limestones, and the third, which is thin in this district, but well developed elsewhere, is called the Woolhope limestone.

2. Page 215:—"The two formations of Ludlow and Wenlock possess so much of a common lithological aspect, and offer such intimate passages from one to the other in the distribution of the organic remains, that they form a very distinct natural sub-group, which I have termed Upper Silurian. The expediency of thus grouping them will be apparent when these deposits are traced over a more extended area; for whenever the bands of limestone thin out, the masses, having an uniform argillaceous or mudstone character, are so blended, particularly when they occur together in one mountain mass—as in the Long Mountain, Salop, the adjacent parts of Montgomeryshire, and in Radnor Forest—that the subdivisions, which are clear in this (the Wenlock) district, can no longer be detected."

3. Speaking of the country about Radnor Forest and Clun, at page

316, he says:—"In this district, there being no trace of limestone, it is impracticable to subdivide the mass into formations, or even to endeavour to separate with accuracy the Ludlow from the Wenlock formation, the whole representing the Upper Silurian rocks."

4. Page 349:—"Near Caermarthen the Upper Silurian rocks thin out considerably, and are quite incapable of subdivision; for, although a partially fossiliferous gray sandstone, which may be termed Ludlow rock, rises out from beneath the tilestones of the Old Red Sandstone, there is little subjacent schist and shale to represent the lower Ludlock rock, and no trace of subordinate limestone. This member of the Silurian System in Caermarthenshire is so unlike the beds of the same age in Salop, Hereford, and Radnor, that what in these three latter counties is called a mudstone is here represented by a hard, compact sandstone."

5. Page 390:—"To the westward of Narbeth the junction of the Silurian rocks and the Old Red Sandstone is so obscured by dislocation and denudation that it is impossible to determine precisely the age of each underlying stratum, which is successively brought into contact with the Old Red Sandstone. Thus, at Canaston Wood the fossils contained in the Silurian rock compel us to place it in the Caradoc Sandstone; whilst at Milling the *Asaphus caudatus*, and other fossils, would indicate the age of that of Wenlock."

6. Page 173:—"We must not, however, judge of the antiquity of rocks by their mineral aspect, nor even by their lithological structure; for, as I shall have occasion to show, there are many portions of the Old Red Sandstone, particularly in Pembrokeshire, undistinguishable in these respects from the oldest Graywacke rocks; whilst strata of the underlying Silurian System, formerly termed Graywacke, so far from assuming an air of higher antiquity, in numberless cases, and over very large areas, resemble closely some of the younger secondary deposits."

I have selected, out of many, the few foregoing descriptions of localities in the Upper Silurian rocks, to show what great differences there are in the lithological characters of those rocks, the probability that the Upper Silurian type has been mistaken for some other division, and, if they be all true, how difficult it is to choose the best of them as a general type for all the world. The author chose that with the three bands of limestone; but that appears to be the worst of them—the exception rather than the rule. None of the others described in the foregoing quotations have any limestone, and, so far, they are more nearly like each other, being all, as it is said, overlaid with Old Red Sandstone.

There are many bands of red sandstone and red grit in the Graywacke group, and hence some of them appear to me to have been mistaken for others. The Old Red Sandstone of Herefordshire, and the Old Red Sandstone of the carboniferous rocks, are two very different things. The first is a subdivision of the Silurian rocks, and its beds lie conformably on those rocks; the second is the lowest member of the carboniferous rocks in Ireland and other places, and lies always unconformably

on the inferior older rocks, as I have shown in a paper printed in the "Journal of the Geological Society of Dublin," vol. vii., p. 115. Both kinds occur in Herefordshire and Brecknock—the first forming the great mass of brown and green grits of those counties; the second occurs at the Vans of Brecon, and continues below the limestone along the northern outcrop of the coal-field of South Wales. This is the upper member of the Old Red Sandstone of the Silurian System, called "quartzose conglomerates and sandstones," which is represented as a part of, and its beds conformable with, the underlying rocks; but those conglomerates have been shown by Sir H. De La Beche to dip conformably under the overlying carboniferous limestone, and to lie unconformably on the brown grits of the hills of Brecon.—Memoirs of Geol. Surv. of Great Britain, vol. i., p. 60. The same thing is shown by Professor Sedgwick, British Pal. Foss., Introd., p. 28.

The two localities, Nos. 4 and 5 (Caermarthen and Narbeth), appear to be so different from the others that, for my part, I would at once join Professor Phillips, and put all the Upper Silurian localities of the Silurian System described west of Llandilo into his lower regions.

From these views it will be seen that I look upon the arrangement of the Silurian strata, as made out by the author, objectionable, because the model district from which the arrangement was made is a small and a peculiar district, and results deduced from it cannot be applied to other districts which bear no physical resemblance or analogy to it, and also because the columns are not recorded with integrity. When the Dudley and Horeb Chapel fossils were put into what is called the Wenlock column, the Wenlock column was neither one thing nor the other: it was spoiled as an item for philosophy.

I would suggest that those who take an interest in this matter should not take all this at my word, or according to my method; but let each man strike out a way to examine the subject for himself. I may take an erroneous view of how this examination ought to be conducted. Human views are fallible. I cannot pretend to know the subject better than others, but it so happened that I had good opportunities in Ireland.

I am sorry for differing in my views from any contemporary, but I cannot help it. I look upon the natural succession of rocks to be entitled to take rank before any artificial arrangement made from fossils, however plausible. Scientific men should be glad to hear the opinions of those that differ from them—how widely it matters not, so long as they are honest.

England, I believe, was the first place, and Sir Roderick Murchison the first man in Europe, that endeavoured to reduce to system, by means of fossils, the probable succession, in bands or in groups, of the *Graywacke* rocks as a whole; and, though he may not have succeeded in his views, the geologists of the world are deeply indebted to him, not for making the system of seven columns, nor for making the upper and lower divisions of his system out of the materials he used on that occasion, but

for searching for fossils, and for figuring, engraving, describing, and publishing those he found. This part of his labours is a lasting benefit to the science. He was once a soldier. I heard him say so at the meeting of the British Association at Dublin in 1835, and again at the Birmingham meeting in the Cave at Dudley, where he gave his history to a large crowd. From the army he turned to geology—a pursuit to which he had previously no idea he ever would turn. His example stimulated, and his publications assisted men everywhere to pursue the subject. He devoted his talents and his time in the prime of life, and, above all, his fortune (for the money he spent on it was his own), to the service of geology. Where is the other man that has done the like?

But, with all due admiration and respect for the author of the Silurian System, and the high enthusiasm of his devotion to his favourite science, I do not consider any man is bound to adopt his conclusions or his theories, more especially when they happen to be at variance with conclusions drawn from that man's own experience. It is an unpalatable task, and, perhaps, in some degree ungracious, to point out faults in the work of any one. In this case I have no doubt but that the author himself would be the very first to correct any error in his system, if such error were clearly laid before him, so as to produce conviction in his mind that the system was erroneous; but it requires a deal of hammering to drive an old idea out of the head of a geologist, and put a new one in its place.

He made, as he says, and as he believes, a discovery in natural history, which had hitherto escaped the most penetrating philosophers. He published a new theory, and the world instantly adopted his opinions, and with such zeal, that we find many respectable writers of the time catching at opportunities to express their approbation of them. Since his views were published, however, very much more information has been collected on this subject, which gives results that appear not to agree with his original theory.

In the last edition of "Siluria," 1859, p. 147, in speaking of the Upper Ludlow rocks, the author says:—"It is chiefly on this upper portion of the formation that the best defined organic remains are found, often preserving the sharpness of their forms and the remains of their original shelly coverings. Here we meet with a profusion of the following fossils:—*Chonetes lata, Orthonota amygdalina, Goniophora cymbæformis, Pterinea lineatula, Pterinea retroflexa, Orbicula rugata, Orthis elegantula, Orthis lunata, Rhynchonella nucula, Turbo corallii, Turbo octavius*, and the curved, shelly, annelid tube, *Serpulites longissimus*. The *Cornulites serpularius*, with the minute *Beyrichia Klædeni*, are also not uncommon."

As this must be presumed to be the most correct reading published in any of the author's works, I will take those fossils individually, and try their merits by the present state of our knowledge on the subject, and note if they be found in any lower localities.

Chonetes lata: Got in six localities of Phillips's lower zones in the western part of South Wales.—Mem. Geol. Sur., ii. 289.

Br. Pal. Fos., p. 250: One locality, Middleton Park, Llandeilo.

In Ireland: Got in four counties, Tyrone, Galway, Waterford, and Kerry.

Orthonota amygdalina, Mem. Geol. Sur., ii. 265: Three localities, in the lower zones of Phillips.

In Ireland: Not found.

Goniophora cymbæformis, Mem. Geol. Sur., ii. 267: Three localities in Phillips's lower zones.

Br. Pal. Fos.: One locality, Hóreb Chapel.

Ireland: One locality, Galway.

Pterinea lineatula, Mem. Geol. Sur., ii. 271: Six localities in Phillips's lower zones.

Ireland: Two localities, Galway and Kerry.

Pterinea retroflexa, Mem. Geol. Sur., ii. 271: Eight localities in Phillips's lower zones.

Br. Pal. Fos.: One locality, Horeb Chapel.

In Ireland: Two counties, Galway and Kerry.

Orbicula rugata, Mem. Geol. Sur., ii. 276: Two localities near Builth.

In Ireland: Not found.

Orthis elegantula, Mem. Geol. Sur., ii. 288: Thirty-eight localities in South Wales, western region.

Br. Pal. Fos., p. 217: Eighteen localities.

Ireland: Five counties, Tyrone, Galway, Kildare, Waterford, and Kerry.

Orthis lunata, Mem. Geol. Sur., ii. 290: One locality in western region of South Wales.

Br. Pal. Fos., p. 221: One locality, Goldengrove, western region of South Wales.

In Ireland: Three counties, Tyrone, Waterford, and Kerry.

Rhynchonella nucula, Mem. Geol. Sur., ii. 281: One locality in lower.

Br. Pal. Fos., p. 205: Three localities in lower.

Ireland: Three counties, Tyrone, Galway, and Kerry.

Turbo corallii, Mem. Geol. Sur., ii. 261: Four localities in South Wales, western region.

Ireland: One locality, Kerry.

Turbo octavius (*Euomphalus carinatus*), Mem. Geol. Sur.: Not found.

Br. Pal. Fos.: Got at three localities, which are called Upper.

Ireland: Not found.

Serpulites longissimus, Mem. Geol. Sur., ii. 132: Three localities at Builth.

Br. Pal. Fos.: Only at Aymestry.

Ireland: One locality, Kerry.

Cornulites serpularius, Mem. Geol. Sur., ii. 229: Three localities, lower.

Br. Pal. Fos.: Not recorded.

Ireland: One locality, Kerry.

Beyrichia Klædeni, Mem. Geol. Soc., ii., 234 : Three localities in South Wales, western region.

In Ireland: Two localities, Galway and Kerry.

Out of the above fourteen species, it is seen that ten occur in undoubted lower Silurian localities, as well as in the Ludlow or upper rocks.

		Species.
The Table in the Silurian system contains in the whole		375
Deduct Fishes of the Old Red Sandstone,		18
Remains,		357
Take Lower Silurian species in the Table,		116
Total Upper Silurian species remains,		241
Again, take the fossils put into the Table as Upper Silurian, got outside the boundaries of the original Silurian zones, in the following detached places:—		
Dudley,	52	
Usk, Tortworth, Woolhope, The Malverns,	21	
Marloes Bay, Freshwater East, Llandeilo,	6	
Horeb Chapel,	18	
Felindre,	6	
		103
Total within the boundaries of the original region, between Coalbrook Dale and Aymestry, all Upper,		138

Of which 79 are in the Ludlow column, and 59 in the Wenlock.

Thus it may be seen that the number in the columns of the Upper Silurian zones in the Table are swelled out to 241 species, while the number actually got within the boundaries is 138. The external scattered tribes are almost equal to the native standing army.

In the comparisons I mean presently to make, none of the fossils in the new table can be made use of except those which are recorded in the original Silurian System, which may be known by reference to the first double column of my table. It is on the list printed in that work that depends the efficacy of the seven zones, the upper and lower divisions, and the whole system. I shall examine a few localities by comparing the Upper Silurian fossils of the original list, as copied and given in the first column of my new table, with the discoveries made since by Phillips and M'Coy, and see how those so-called upper fossils bear the test of this comparison.

Taking a cursory glance over the columns of my table, and comparing the first division of it, which consists of two columns, and represents the fossils of the original Silurian System, Upper and Lower, with the second, which represents South Wales, it is surprising what a number of Murchison's upper fossils are found in Phillip's lower zones; and again, the first column, compared with the third, the British Palæozoic Fossils, a great number additional come down. Lastly, compare the fossils of the Silurian System with the five columns of M'Coy's Silurian Fossils of Ireland, and numerous species go farther in the same direction, that is, into Lower Silurian zones.

I come now to test Dudley as an Upper Silurian locality. The fossils got there, and recorded by the author in the original table, and the letter-press localities, were fifty-two. Those obtained by Professor Sedgwick, and printed in the "British Palæozoic Fossils," p. 350, are forty-five; but of these, thirteen species are the same as the author got, so that Professor Sedgwick got thirty-two others, of which nine were new ones. This number, added to fifty-two, as above, makes eighty-four species in all got by these two gentlemen at Dudley. Thirty-four of these are corals, or crinoids, two natural divisions which abound in this locality, and are extremely scarce or wholly absent in others. Taking those thirty-four corals, or crinoids, for the present, from the eighty-four above, leaves fifty species. If those fifty be strictly examined by my new table, it will be found that forty-nine of them have been found in Lower Silurian localities in other places in Great Britain and Ireland, leaving only one species exclusively Upper. Even leaving in the crinoids and corals from the whole eighty-four, take forty-nine lower ones, there remain thirty-five upper ones, corals and all. Whether ought Dudley be called Upper or Lower Silurian? More fossils belonging to Lower Silurian columns exist in it than belong to Upper; but Dudley, physically, cannot be both Lower and Upper. It is one and undivided, and the majority of its fossils belongs to the Lower. It is, therefore, as one locality, Lower Silurian.

It appears to me that the Dudley limestone and shale have not a much greater preponderance of fossils peculiar to it than many other fossiliferous localities in the Graywacke rocks. Sixteen crinoids are the chief fossils of that kind found in the gray argillaceous limestone of that district. This is not deserving any more especial notice than another locality deserves for graptolites, or a third for brachiopoda. Wenlock and Dudley, to be sure, have yielded some fossils which are common to both; this is a significant fact; but I believe it to be more owing to the limestone, and its vicinity, which is palpable in both localities, than to their being equivalent parts of the same zone, of which there is no proof. Corals and crinoids are the peculiar kinds of fossils in both. The calcareous element is favourable to the production of coral everywhere in the system, above and below; at Wenlock in Shropshire, say above; at Portrane in Dublin, below; at Kilbride in Galway, in the very bottom; at Ferriter's Cove in Kerry, also low in the series. This is the case also in the mountain limestone at Hook Head in Ireland, where the

finest specimens of crinoids have been obtained. This disposition of particular animals to flourish in certain mineralogical deposits appears to have prevailed in early times, and it continues to the present day; for we find the cockle and the razor-fish inhabiting sand; lutraria and scrobicularia in mud; muscles and limpets attached to rocks; and any one of these will not live in the habitat of another.

The foregoing trial regarding Dudley is such as, if doubted, every man may make for himself, as I have already said. I trust I have explained satisfactorily the materials from which my table is constructed, and the manner in which those materials have been applied. I made detailed lists of the names of the fossils in each case, and would print them all, only for a desire to keep this paper short; such lists, except to one immediately concerned, would be of no general interest.

No man living can tell whether the Dudley limestone belongs to the bottom, the middle, or the top of the Graywacke system of rocks. It is the top of an anticlinal convolution. Can a man tell by physical means, if he stand on the top of any convolution, well covered up in the grounds to the east and to the west with other formations, whether that rock he stands on be one of the first of that group ever deposited, or one of the last? Certainly not. Being the top of an anticlinal curve, it dives into the earth at both sides to an unknown depth. It dips on the west side at an angle of about 45°. At two miles distance westward, that band of limestone will be above 10,000 feet in perpendicular depth below the horizon of Dudley. Wenlock is 23 miles to the west of it. It is a wild conjecture to say that the limestone at Wenlock is the equivalent of the limestone at Dudley, when there is no trace of physical connexion visible between them. Besides this, there is but one band of limestone visible at Dudley, in one part of it, which is separated into two at another part; there are three different parallel bands of limestone in the original Silurian district. This makes them still more unlike each other as equivalents. The Dudley limestone, too, may be fugitive in its extended development, as well as the bands called Wenlock, Ludlow, or Aymestry limestones; and this fugitive character in any bands of rock makes them unfit to be selected for reference, to determine the position of any zone in the Graywacke of other regions.

Let us next examine Horeb Chapel. This locality, as already stated, is sixty miles south-west of the original Siluria. There are two corroborating circumstances to show that it belongs to the lower zones: the first is, that Professor Phillips has put Llandeilo and its vicinity, including Horeb Chapel, into his western, or lower region.—Mem. Geol. Surv. Great Britain, p. 248. The second is from the fossils. From Horeb Chapel there are recorded in the Silurian system 19 species. Tried by the same test as Dudley, 16 of those are found in lower zones, leaving only 3 exclusively upper. Horeb Chapel is, therefore, with the great majority of its fossils, Lower Silurian.

At Benson Knot, in Westmoreland, Professor Sedgwick got 50 species of fossils. He gives a list of them at page 352 of the Brit. Pal. Fos., of which 16 are new, named by Professor M'Coy, so that he found 34

species known before. Trying this list by the same test as before, it includes 31 which have been found in lower zones in other places. From 34 take 31, leaves only 3 species known exclusively as upper, at Benson Knot. By its fossils it is, therefore, Lower Silurian.

Brigsteer, another locality in Westmoreland, put into Upper Silurian, turns out nearly the same way. Out of 15 species, leaving out 4 new, there are 8 lower and 3 upper.

Take the original Upper Silurian district in itself, pure and unmixed. It may be represented by the space extending between Coalbrook Dale and Aymestry, twenty miles long and four miles wide. This space has no detached part; it comprises the outcrops of the three zones of limestone, and the intervening shales, which have been specially called the Upper Silurian district. The fossils obtained within this space must, undeniably, be Upper Silurian fossils, if any such there be.

I went carefully through the Silurian System with such maps as were within my reach, and from the table of fossils, and the letter-press localities, I culled out and made a list of all the fossils that were obtained within this area, as well as I could determine them; of course, not including Dudley, nor any locality beyond the boundaries so fixed upon.

The result turned out to be, that there are within the space defined 122 species. This number does not include the fishes of the so-called Old Red Sandstone, nor 13 species of mollusca in the same zone, nor a few plants, and doubtful items. Testing this truly Upper Silurian area, the model farm of the Silurian System, as it may be called, by the new table—of these 122 species, 82 will be found to occur in Lower Silurian zones in other places, and only 40 upper species remaining peculiar to the district, which have not yet been found in any lower zone; so that this district, like Dudley, with 82 lower and 40 upper species, must be, with the majority of the fossils, called a Lower Silurian district.

This extraordinary result could not have been foreseen by the author at the time of the publication of the Silurian System. It has been developed by discoveries and publications made since that time. It appears to me that at the present day it is useless to try to uphold the old theory any longer; that the seven columns must vanish, and even the upper and the lower, the two great subdivisions of the system. We must henceforth be content to take the Old Graywacke as a whole, as one system, which does not bear subdivision into palæontological zones.

Professor Sedgwick himself has had a hand in the arrangement of the zones he examined. Seeing the manner in which those trials have turned out generally, doubts occurred regarding North Wales, where there is on the map of Siluria, 1859, a large area shown as Upper Silurian rocks. M'Coy says, Brit. Pal. Fos., p. 325:—"I have drawn up the following lists of all the localities, arranged in alphabetical order, to facilitate reference, and to each locality Professor Sedgwick has added his geological interpretation of the age of the rock there occurring, from which the specimens were obtained." Those lists afford a facility of testing some of the localities of this country, some of which he calls Caradoc or

Bala, some of them Wenlock shale, some Ludlow rocks, &c., &c. I shall copy the fossils of a few of the upper localities, and try them by the usual test, with one exception, and thereby see how they turn out according to the Professor's own interpretation. The exception just alluded to is, that I will not make use of the third division of the table, his own upper and lower zones, in deciding for or against his own views, as to what fossils belong to the upper, or what fossils to the lower part of the Graywacke.

		Sil. Sys.		Phill.		
	Peculiar.	Upper.	Lower.	Upper.	Lower.	Irish Counties.
Cwm Craig dhu, Lower Ludlow.						
Hemythiris navicula,	....	1	....	4	2	4
„ nucula,	....	1	....	4	1	3
Chonetes lata,	....	1	....	....	3	4
Pterinea tenuistriata,	....	....	....	....	....	1
Leptodomus amygdalina,	....	1	....	5	2	....
Cardiola interrupta,	....	1	....	4	1	1
Dinas Bran, Llangollen, Lower Ludlow and Wenlock Shale.						
Spongarium Edwardsi,	....	1	....	....	....	....
Serpulites dispar,	1	....	....	....	....	....
Hemythyris nucula,	....	1	....	4	1	3
„ navicula,	....	1	....	4	2	4
Orthis lunata,	....	1	....	5	2	3
Ambonychia acuticostata,	1	....	....	....	....	....
Cucullella coarctata,	....	....	....	....	1	1
Nucula levata,	1	....	....	....	....	....
Theca Forbesii (Usk),	....	....	....	1	....	....
Holopella gracilior,	1	....	....	....	....	....
Orthoceras laqueatum,	1	....	....	....	....	....
„ tenuicinctum,	....	....	....	....	....	4
Cycloceras tracheale,	....	1	....	1	1	....
Erw Gilfach, Lower Ludlow.						
Hemythyris navicula,	....	1	....	4	2	4
Orthis lunata,	....	1	....	5	2	3
Pterinea tenuistriata,	....	....	....	....	....	1
Cardiola interrupta,	....	1	....	4	1	1

	Peculiar.	Murch. Upper.	Murch. Lower.	Phill. Upper.	Phill. Lower.	Irish Counties.
Llanfair Road, Welchpool, Wenlock Shale.						
Graptolithus Murchisoni,	....	....	1	....	4	....
Beyrichia Klœdeni,	....	....	....	4	2	2
Odontochile caudata,	....	1	....	6	8	1
Leptæna minina,	....	1	....	1	....	....
Llangynyw, Welchpool, Wenlock Shale.						
Graptolithus Ludensis,	....	1	....	8	8	1
Favosites alveolaris,	....	1	1	5	8	3
Portlockia Stokesii,	....	....	....	1	1	2
Calymene brevicapitata,	....	....	....	....	2	2
Spirifera insularis,	....	....	....	....	1	1
Leptæna quinquecostata,	....	....	....	....	....	2
Cardiola interrupta,	....	1	....	4	1	4
Arca Edmondiiformis,	1	....	....	....	....	....
Orthoceras angulatum,	....	1	....	4	2	1
Orthoceras subundulatum,	....	....	....	....	....	2
Mynydd Y Gaer, Denbigh, Lower Ludlow.						
Spirigerina reticularis,	....	1	1	6	4	2
Hemythyris navicula,	....	1	....	4	2	4
Hemythyris nucula,	....	1	....	4	1	3
Orthis elegantula,	....	1	....	5	5	5
Leptæna lævigata,	....	1	....	1	....	....
Cardiola interrupta,	....	1	....	4	1	....

I shall make a few observations on the foregoing lists of fossils from six localities of the middle and northern parts of Wales.

Cwm Craig Dhu, called Lower Ludlow, p. 358, has a list of six fossils, of which five were got in the Upper Silurian country by Sir R. Murchison, and appear in his table as Upper Silurian fossils; but it may be seen also that the whole six have been got in Lower Silurian, in five of Phillips' lower or western regions, and in several Irish counties. Those fossils, or this locality, cannot be called Lower Ludlow.

Dinas Bran, near Llangollen, Lower Ludlow, and Wenlock shale, p. 359. Thirteen fossils are recorded from this place. Of these, five are new and peculiar, which cannot be counted, leaving eight known before. Of those eight, two are from upper localities exclusively, and six are from lower zones. Dinas Bran cannot, therefore, be called an Upper Silurian locality.

Erw Gilfach, Lower Ludlow, p. 360. Four fossils were got here; three of them are in the upper zones of the table in the Silurian System, and the whole four occur also in three of Phillips's western regions, and in four Irish counties. This cannot be called Lower Ludlow.

Llanfair Road, Welchpool, Wenlock shale, p. 365. Four species were obtained here, of which one is upper, and three lower. Not Wenlock shale, therefore.

Llangynyw, Welchpool, Wenlock shale, p. 365. Here ten fossils were found, one of which is new. Not one of the other nine is exclusively upper. Four are both upper and lower, and five lower. This is not a Wenlock shale locality, which should have all upper fossils, and no lower.

Mynydd y Gaer, Denbigh, Lower Ludlow, p. 369. Here were obtained six species; one exclusively upper, the other five both upper and lower. This cannot be a Lower Ludlow rock locality.

From those observations and conclusions it appears that there are no just palæontological grounds for extending the Upper Silurian rocks into North Wales at all. Some of the species in the six foregoing lists are repeated in other localities. There are forty-three names enumerated. Of those forty-three, nine are repetitions, and five are new, which cannot be accounted as belonging to upper or to lower. Those fourteen, taken out of forty-three, leaves twenty-nine species known before, of which four only are exclusively upper. The other twenty-five have been found in the western region of South Wales, or in Irish counties, which I count all the same.

It appears to me that Professor Sedgwick, in fixing on his palæontological zones, took his cue from the table in the Silurian System. Out of the twenty-nine species above mentioned, twenty-three of them are found in the upper columns of that table, and not in the lower. This might have influenced the Professor in determining that a large portion of the rocks of North Wales is Wenlock shale and Ludlow rocks. He would have believed that the twenty-three species above alluded to were exclusively Upper Silurian fossils, and according to the creed laid down in the table, he would have classed all rocks which contained some of those fossils as Upper Silurian. If this be so, he is one man that the table has led astray.

The original subdivision of the Silurian System into seven zones was a mere theory, and not a bad idea for an experiment; but it has not been supported by recent observation. A strong point in the refutation of it is a glance at the table itself, in Siluria, Ed. 1859, p. 532. Take a fossil (*Halysites catenularius*) in that table, and it may be seen that it occurs in four out of the seven zones; *Stenopora fibrosa* in five; *Graptolithus priodon* in four zones; *Orthis elegantula* in five; *Calymene Blumenbachii* occurs in four. A large proportion of the fossils of the table occurs in two or three or four of the zones. This is not according to what might be expected by the precision attributed to a zone which is assumed to contain fossils of a kind which will not occur in any other. This principle pervades the whole work as first published. At present,

fossils appear to be taking the lead, and superposition is often disregarded. The rocks appear to be made to fall into whatever place the palæontologist may assign.

In Siluria, 1859, p. 175, it is said:—"The overlying position of the schistose strata of the Pentland hills has been indicated; and as the Orthoceratites discovered in them most resemble those of the Wenlock formation, and as a Wenlock Brachiopod (*Rhynchonella compressa*) has also been found in them, as before stated by Mr. Giekie, there is little doubt that those schists are younger than any of the Girvan beds, and are of Upper Silurian age."

The author of "Siluria" is evidently not a doubter, when the fancy strikes him. I confess I would doubt that the geology of the Pentland Hills should be determined upon such evidence as a few Orthoceras resembling each other, which is no proof at all, for they all resemble each other, and one Rhynchonella identical with one got in the Wenlock rocks. When I see that so many fossils occur in two, three, four, or five Silurian zones, I would not readily believe that, from such slight evidence as one fossil, such a group as the Pentland Hills should be called a Wenlock group.

Again—*Terebratula navicula*—he says, Siluria, p. 201:—"This shell is of great geological value, being extremely persistent, and marking always the same horizon, even to a distance of nearly one hundred miles. The beds which it occupies are so calcareous, and pass so naturally into the Aymestry limestone, that they may in all such cases be grouped with that rock."

Such dogmas will not hold. Professor Phillips got this fossil (*Terebratula navicula*) at Llandilo and at Builth; Professor Sedgwick got it at Mayhill, Welchpool, Dinas Bran, Mynydd y Gaer, Cwin Craig Dhu, Erew Gill Fach—Br. Pal. Fos., p. 204; and I got it in Tyrone at Tirnaskea, in Galway at Glencraff, in Kildare at the Chair, and in Kerry at Doonquin and Tieravane. All the above localities cannot be grouped with the Aymestry rock, nor, as appears to me, any of them. From this, every one can judge for himself what he thinks may be the geological value of a fossil.

The lower part of the Graywacke in Cunemarra, the middle at Dingle, and the upper at Pomeroy, have no suites of fossils contrasting strongly with one another. Whatever peculiarity there is, consists in the extraordinary abundance of some fossils in certain localities; for instance, of *Atrypa hemispherica* in Cunemarra, well exposed at Bunowen, Maume, Cappacorcogue, and Shanballymore; of *Halysites catenularius*, in great abundance at the north side of Ferriter's Cove, near Dingle in Kerry, and at Kilbride in Galway; of Trilobites and Brachiopods at Carrickadaggan in Wexford, at Quillia in Waterford, and at Tirnaskea and Bardahessia in Tyrone. With the exception of those places, which are remarkable for the thousands of specimens of each kind that might be procured in the places named, the other fossils occur in a general way, not only pretty evenly distributed in the lower, middle, and upper parts, but in all the similar districts in Ireland, very nearly alike.

There is seldom in this country a distance of five miles of land anywhere without faults or contortions in the strata—I might say seldom two miles, and often half a dozen in one mile. Those faults are many of them in the valleys where rivers now flow, and the inequalities of hill and hollow are mostly due to them.

The reasoning of the geologist never loses sight of those leading features, contortion and dislocation; and an extensive experience leads him to doubt the continuance of a particular band of rock for any great distance. It is more than usually difficult to follow such band in the Graywacke—the grits and slates of one locality are so much like the grits and slates of another. It is a rare thing for a man to be able to recognise the same band at both sides of a valley, unless indeed there be such an index as a zone of gray limestone, of brown sandstone, or other rock, well distinguished by mineral character or colour. The Wenlock bands of limestone are, perhaps, the greatest length known in a continued zone in the Silurian rocks, and even those, let a geologist only look at the map of Siluria, and note the contortions and shifts in the blue bands near Ludlow.

I might go much more into detail on those points, but it appears to me needless. If the arguments I have adduced be sound, the Silurian System must fall to the ground; if not, it will stand the firmer for being tested.

The worst thing about a controversy of this kind is, that so few of the world understand the subject. No one knows whether the statements I make, or the views I take, regarding Galway or Tyrone be sound or not. They must be taken at my word for the present, and confirmed or denied by future examination. It may be years before the simple truth will be generally known and acknowledged.

North Devon has been called a Silurian district by every geologist who visited it, and wrote upon it before 1838. Sir H. De La Beche, in the Geology of Cornwall, Devon, and West Somerset, says that—"The whole area north of a line from Barnstaple to Clayhanger is Graywacke." —P. 40. Again, he says: "Professor Sedgwick and Mr. Murchison divided the graywackes of North Devon into five subordinate groups." —P. 130.

In 1837 Professor Sedgwick and Mr. Murchison read a paper before the Geological Society of London (Trans. ii., p. 566); they conclude that "The minor groups of South Devon are newer than the rocks of Snowdon and central Cumberland, and older than the Silurian of Murchison."

In 1837, at the meeting of the British Association at Liverpool, the Rev. D. Williams read a paper in which he divided the graywacke of North Devon into seven minor groups, and gave an account of plants found in it.

In January, 1838, Mr. Weaver read a paper to the Geological Society of London, in which he made the rocks of the district into six subdivisions, and said "they constitute a peculiar transition group." The transition of Weaver, I know from himself, and, as may be seen by reference to his writings, is our Graywacke.

We look back on these several views, and it appears that the men of the present day have not much improved upon them. De La Beche, and Williams, and Weaver, appear to have understood what they described, and their opinions are not to be rejected.

In my table all the new fossils, discovered since the Silurian system was printed in 1839, are embodied. In "Phillips's Palæozoic Fossils," there are recorded above sixty species of fossils from North Devon, a district recognized as graywacke by four or five of our most eminent geologists, as above quoted. Above thirty of those fossils have been obtained from the Irish carboniferous limestone and shale, as interpreted by Professor M'Coy, and described in the synopsis of the carboniferous limestone fossils of Ireland. Those fossils are noticed in the "Atlantis," a scientific periodical by the Professors of the Catholic University at Dublin, vol. ii., p. 271. I am fully satisfied that North Devon is graywacke, and that the fossils of it belong to that system. I have accordingly introduced them into the table in this paper.

Regarding South Devon, the authors say (Trans. Geol. Soc., v., 651): —"The upper limestone in the eastern parts of South Devon generally appears in the form of great unconnected masses, more or less tabular, surmounted by no newer deposits. In its structure, as well as position, it strongly reminded us of the Great Scar limestone which rests unconformably on the slate rocks of Cumberland and Westmoreland. From this circumstance, and, perhaps, still more from some of its fossils, it has been occasionally confounded with the carboniferous limestone."

This short description is certainly very like that of the carboniferous limestone in the neighbourhood of Sligo, in Ireland; but there is one thing dissimilar, and that is, in Sligo the coal-measures where they occur rest on the limestone conformably in all cases; whereas, Mr. Austen, in a paper in the Trans. Geol. Soc., London (second series, vi., 458, figs. 9, 10), shows clearly that the culm-measures of Devonshire, in one place, at least, near Ashburton, rest unconformably on the limestone of Newtown Bushel. This fact, of the coal-measures lying on the inferior limestone at Sligo conformably, and at Ashburton unconformably, appears to settle the matter, and goes to show that the limestone of Newtown Bushel, notwithstanding the great proportion of its carboniferous limestone fossils, is not the carboniferous or mountain limestone. Nevertheless, where such a similarity exists in the physical aspect of the limestone, and in the fossils of both localities, I would not venture to put the South Devon fossils into my table without an actual survey of parts of that country.

The generic names of the fossils in the table have been much altered, as already alluded to, by Messrs. Salter and Morris, from what they formerly were. This alteration appears to lead to a more simple classification, and, as I have no doubt that due regard to generic character is preserved, it will be a great improvement. It is devoutly to be wished that with this reform we may have an end of the puzzling and complicated manner of nomenclature that was in use the last forty years.

Many geologists know fossils by the old names, and cannot be yet aware of the recent changes. For the convenience of such persons I

give the following list of the chief names of genera that were altered. It is in alphabetical order, and consists of two columns, of which the first is the new names; the second, the old corresponding names. The specific names generally remain unchanged, but where both have been altered I give the new and the old in full in my new table.

The following are the chief names, in alphabetical order, of genera that were altered in the Mollusca:—

Old Name.	New Name.
Acroculia.	Capulus, Nerita, Acroculia.
Arca (put out).	Ctenodonta.
Atrypa.	Rhynchonella, Pentamerus, Athyris, Atrypa.
Avicula.	Pterinea, Avicula.
Bellerophon.	Euomphalus, Bellerophon.
Cardium (out).	Cardiola.
Cucullæa (out).	Cucullella.
Cypricardia (out).	Goniophora, Orthonota, Sanguinolites.
Euomphalus.	Raphistoma, Trochonema, Bellerophon, Euomphalus.
Helminthochiton (out).	Chiton.
Inoceramus.	Ambonychia, Inoceramus.
Leptagonia (out).	Strophomena.
Leptæna.	Chonetes, Strophomena, Orthis, Leptæna.
Leptodomus (out).	Orthonota.
Littorina (out).	Cyclonema.
Lucina (out).	Anodontopsis.
Maclurea (out).	Ophileta.
Modiola (out).	Orthonota, Modiolopsis.
Modiolopsis.	Orthonota, Modiolopsis.
Mytilus.	Modiolopsis, Cardiola, Mytilus.
Mya (out).	Grammysia, Orthonota.
Naticopsis (out).	Holopæa.
Nucula (out).	Ctenodonta, Cucullella, Grammysia.
Orbicula (out).	Discina.
Orthis.	Leptæna, Strophomena, Orthis.
Orthonota.	Grammysia, Orthonota.
Pectunculus (out).	Ctenodonta.
Pileopsis (out).	Acroculia.
Pleurorhynchus.	Conocardium, Pleurorhynchus.
Pleurotomaria.	Murchisonia, Pleurotoma, Trochonema, Pleurotomaria.
Polyphemus (out).	Macrocheilus.
Pullastra (out).	Anodontopsis, Ctenodonta, Modiolopsis.
Terebratula (out).	Atrypa, Retzia, Rhynchonella.
Trochus.	Cyclonema, Holopæa, Raphistoma, Trochus.
Turbo.	Cyclonema, Platyschisma, Trochonema, Turbo.
Turritella (out).	Holopella.

The Corals, the Crinoids, the Bryozoa, and the Crustacea have, m of them, the whole name altered. Where numerous specific names l been so altered, to give the new names would require almost anot list. I must refer those to the table, where I have given one synon for each, and that the most common I know..

AUTHORITIES REFERRED TO IN THE TABLE, WITH THE CONTRACTIONS.

A. N. H.,	Annals of Natural History.
Ag. P. Fos.,	Agassiz, Poissons Fossiles.
Aust. A. N. H.,	Austin, Annals of Natural History.
Aust. Mon. Crin.,	Austin, Monograph of Crinoidea.
Bar. S. S. Boh.,	Barrande, Systeme Silurien de la Bohême.
Brong.,	Brongniart.
Dav. Bul. S. G.,	Davidson, Bulletin Société Geologique.
Dec. G. S.,	Decades of Geological Survey.
Edw. A. Mus.,	Edwards and Haime, Archives du Museum.
Edw. Br. Cor.,	Edwards, British Corals.
Flem. Br. An.,	Fleming, British Animals.
Forb. M. G. S.,	Forbes, Memoirs of the Geological Survey.
Geol. Trans.,	Geological Transactions.
Gold. Pet.,	Goldfuss, Petrefacta Germaniæ.
Hall, P. N. Y.,	Hall, Palæontology of New York.
Hark. G. J.,	Harkness, Geological Journal.
His.,	Hisinger.
Jones, A. N. H.,	Jones, Annals of Natural History.
Journ. Geol. Soc.,	Journal of the Geological Society of London.
Lam.,	Lamarck.
Linn. Sil. Sys.,	Linnæus, Silurian System.
Lons. Sil. Sys.,	Lonsdale, Silurian System.
M'Coy, Pal. Fos.,	M'Coy, Br. Paleozoic Fossils.
M'Coy, Sil. Fos.,	M'Coy, Silurian Fossils of Ireland.
Mem. Geol. Sur.,	Memoirs of the Geological Survey.
Mur. Sil. Sys.,	Murchison, Silurian System.
Nicol, G. J.,	Nicol, Geological Journal.
Park. Org. Rem.,	Parkinson, Organic Remains.
Phil. G. Sur.,	Phillips, Geological Survey.
Phil. P. F.,	Phillips, Paleozoic Fossils.
Phil. Sil. Sys.,	Phillips, Silurian System.
Port. G. Rep.,	Portlock, Geological Report.
Salt. G. Sur.,	Salter, Geological Survey.
Salt, P. Fos.,	Salter, Palæozoic Fossils.
Salt, Sil.,	Salter, Siluria.
Salt. Sil. Fos.,	Salter, Silurian Fossils of Ireland.
Sedg. G. J.,	Sedgwick, Geological Journal.
Sow. Sil. Sys.,	Sowerby, Silurian System.
Thom. G. J.,	Thompson, Geological Journal.

SYNOPTICAL TABLE.—LIST OF FOSSILS AND LOCALITIES.

			Mur.		Phil.		Sedg.		Irish, M'Coy.				
Name.	Authority.	Locality.	Upper.	Lower.	Upper.	Lower.	Upper.	Lower.	Tyrone.	Galway.	Kild. Dubl.	W. W. W.	Kerry.
PLANTÆ.													
Actinophyllum plicatum.	Phil. G. Sur. 386.	Perton, Stoke Edith.	.	.	1	.	*	.	.	.	.	.	.
Chondrites acutangulis.	M'C. Pal. Fos. 1A.	Low Fell.	.	.	.	.	.	*	.	.	.	.	.
,, antiquus.	Brong.	Ludlow.	.	.	.	.	*	.	.	.	.	.	.
,, informis.	M'C. Pal. Fos. 1A.	Whiteless.	.	.	.	.	.	*	.	.	.	.	.
,, regularis.	Hark. G. J. xi. 473.	Barlae Quarry.	.	.	.	.	.	*	.	.	.	.	.
Cruziana semiplicata.	Salt. Sil. 45.	Bangor.	.	.	.	.	.	*	.	.	.	.	.
Fucoides gracilis.	Hall, N. Y.	Malvern, Phil.	.	.	.	.	*	.	.	.	.	.	.
Palæochorda major.	M'C. Pal. Fos. 1A.	Kirkfell.	.	.	.	.	.	*	.	.	.	.	.
,, minor.	M'C. Pal. Fos. 1A.	Scawfell, Whitèless.	.	.	.	.	.	*	.	.	.	.	.
,, teres.	Hark. G. J. xi. 474.	Barlae Quarry.	.	.	.	.	.	*	.	.	.	.	.
Spongarium æquistriatum.	M'C. Pal. Fos. 42.	Benson Knot.	.	.	.	.	*	.	.	.	.	.	.
,, Edwardsii.	Murch. Sil. Sys. 696.	Bircher Common.	*	.	.	.	.	*	.	.	.	.	.
,, interlineatum.	M'C. Pal. Fos. 43.	Benson Knot.	.	.	.	.	*	.	.	.	.	.	.
,, interruptum.	M'C. Pal. Fos. 43.	Spital, Kendal.	.	.	.	.	*	.	.	.	.	.	.
Trichoides ambiguus.	Hark. G. J. xi. 474.	Barlae Quarry.	.	.	.	.	.	*	.	.	.	.	.
AMORPHOZOA.													
Acanthospongia Siluriensis	M'C. Sil. Fos. 67.	Ardaun.	.	.	.	.	.	.	.	*	.	.	.
Cliona antiqua[a].	Port. G. Rep. 360.	Desertcreat.	.	.	.	.	.	.	*	.	.	.	.
Cliona prisca.	M'C. Pal. Fos. 260.	Malverns.	.	.	.	.	.	.	.	.	.	.	.
Cnemidium tenue.	Lons. Sil. Sys. 694.	Dudley.	*	.	.	.	*	.	.	.	.	.	.
Verticillopora abnormis.	Lons. Sil. Sys. 694.	Pyrton Passage.	*	.	.	.	.	.	.	.	.	.	.
ZOOPHYTA.													
Acervularia ananas[b].	Linn. Sil. Sys. 688.	Dudley, Ledbury.	*	*	.	.	*	.	.	.	.	.	.
Alveolites Labechei[c].	Edw. Sil. Sys. 683.	Benthall Edge, Uggool.	*	.	5	2	*	.	.	*	.	*	*
,, Grayi.	Edw. Br. Cor. 262.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
,, pulchellus.	Edw. Br. Cor. 267.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
,, repens[d].	Lons. Sil. Sys. 680.	Benthall Edge.	*	.	4	.	*	.	*	.	.	.	*
,, seriatoporides.	Edw. Br. Cor. 263.	Dudley, Wenlock.	.	.	.	.	*	.	.	.	.	.	.
Arachnophyllum typus[e].	Lons. Sil. Sys. 689.	Dudley, Uggool.	*	.	2	.	*	.	.	*	.	.	.
Aulachophyllum mitratum	Edw. Br. Cor. 280.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
Aulopora consimilis.	Lons. Sil. Sys. 675.	Dudley.	*	.	1	.	*	.	.	.	.	.	.
,, serpens.	Lons. Sil. Sys. 675.	Dudley.	*	.	8	8	.	.	.	.	.	.	*
Chætetes Fletcheri[f].	Edw. Br. Cor. 267.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
,, Petropolitanus[g]	Edw. Br. Cor. 264.	Bonmahon.	.	.	.	.	.	.	.	.	*	**	*
,, pulchellus.	Edw. Br. Cor. 267.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
Clisiophyllum vortex.	M'C. Pal. Fos. 33.	Wenlock.	.	.	.	.	*	.	.	.	.	.	.
Chonophyllum perfoliatum	Edw. Br. Cor. 291.	Dudley, Torquay.	.	.	.	.	*	.	.	.	.	.	.
Cœnites intertextus[h].	Lons. Sil. Sys. 692.	Dudley, Wenlock.	*	.	4	.	*	.	.	.	.	.	.
,, juniperinus[i].	Lons. Sil. Sys. 692	Dudley.	*	.	4	.	.	.	.	.	.	.	.
,, labrosus.	Edw. Br. Cor. 277.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
,, linearis.	Edw. Br. Cor. 277.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
,, strigatus.	M'C. Pal. Fos. 22.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
Cyathoxina Siluriensis.	M'C. Pal. Fos. 36.	Kendal.	.	.	.	.	*	.	.	.	.	.	.
Cyathophyllum augustum[j].	Lons. Sil. Sys. 690.	Coal Moors, Lickey.	*	*	2	.	.	.	.	.	.	.	.
,, articulatum.	Lons. Sil. Sys. 690.	Wenlock.	*	.	3	1	.	.	.	*	*	.	*
,, flexuosum.	Lons. Sil. Sys. 689.	Malvern, Uggool.	*	.	1	1	.	.	.	*	.	.	.
,, Loveni.	Edw. Br. Cor. 280.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
,, truncatum[k].	Linn. Sil. Sys. 690.	Ledbury, Portrane.	*	.	5	.	.	.	.	.	*	.	.
Cystiphyllum brevilammellatum.	M'C. Pal. Fos. 32.	Wenlock.	.	.	.	.	*	.	.	.	.	.	.

[a] Vioa antiqua, Port.
[b] Cyathophyllum dianthus.
[c] Favosites spongites.
[d] Millepora repens.
[e] Acervularia Baltica.
[f] Favosites spongites.
[g] Favosites Petrop.
[h] Limaria fruticosa.
[i] Limaria clathrata.
[j] Cladocora sulcata.
[k] Cyathophyllum dianthus.

Name.	Authority.	Locality.	Mur.		Phil.		Sedg.		Irish, M'Coy.				
			Upper.	Lower.	Upper.	Lower.	Upper.	Lower.	Tyrone.	Galway.	Kild. Dubl.	W. W. W.	Kerry.
ZOOPHYTA—*continued.*													
Cystiphyllum cylindricum.	Lons. Sil. Sys. 691.	Benthall Edge, Ardaun.	*	.	.	.	.	.	.	*	.	.	.
,, Damnoniense.	Lons. G. Tr.	Cannington Park.	.	.	.	.	*	.	.	.	.	.	.
,, Grayi.	Edw. Br. Cor. 297.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
,, Siluriense.	Lons. Sil. Sys. 691.	Dudley, Wenlock.	*	.	2	.	.	.	.	*	.	.	.
Diphyphyllum flexuosum[a]	D'Orb. Prod. 48.	Wenlock, Ferriters.	.	.	1	1	*	.	.	.	.	.	*
Favosites alveolaris[b].	Lons. Sil. Sys. 681.	Wenlock, Caradoc.	*	*	5	8	.	**	.	*	*	.	*
,, cristata[c].	Lons. Sil. Sys 684.	Ludlow, Aymestry.	*	.	3	1	.	.	*	**	*	*	*
,, Gothlandica[d].	Lons. Sil. Sys. 682.	Dudley, Lambay.	*	*	4	8	*	*	.	**	*	.	.
,, Hisingeri.	Edw. Br. Cor. 259.	Cullimore's Quarry.	.	.	.	.	*	*	.	.	.	.	.
,, multipora.	Lons. Sil. Sys. 683.	Wenlock, Marloe's Bay.	*	.	8	2	.	*	.	**	.	.	**
Fistulipora cribrosa.	Phil. Pal. Fos. 17.	Pilton.	.	.	.	.	*	.	.	.	.	.	.
,, descipiens.	M'C. Pal. Fos. 11.	Aymestry.	.	.	.	.	*	.	.	.	.	.	.
Goniophyllum Fletcheri.	Edw. Br. Cor. 290.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
,, pyramidale[e].	M'C. Sil. Fos. 60.	Ardaun, Kilbride.	.	.	.	.	.	.	.	*	.	.	.
Halysites catenularius[f].	Linn. Sil. Sys. 685.	Ludlow, Caradoc.	*	*	5	8	*	**	*	***	*	.	***
Heliolites favosus[g].	M'C. Pal. Fos. 15.	Girvan.	.	.	.	.	.	*	.	.	.	.	.
,, Grayi.	Edw. A. Mus. 217.	Walsall.	.	.	.	.	*	.	.	.	.	.	.
,, inordinatus[h].	Lons. Sil. Sys. 687.	Llandeilo.	.	*	.	1	.	*	.	.	*	.	*
,, interstinctus[i].	Lons. Sil. Sys. 686.	Dudley, Pembroke.	*	.	5	8	*	*	.	*	*	.	*
,, megastoma[j].	M'C. Pal. Fos. 16.	Wenlock, Uggool.	.	.	.	.	*	*	.	*	.	.	*
,, petalliformis[k].	Lons. Sil. Sys. 687.	Dudley, Goleugoed.	*	.	.	.	.	*	.	*	.	.	.
,, subtilis[l].	M'C. Pal. Fos. 17.	Mulock, Ayr.	.	.	.	.	.	*	.	.	.	.	.
,, tubulatus[m].	Lons. Sil. Sys. 687.	Dudley, Goleugoed.	*	.	4	1	*	*	.	.	.	.	.
Labechia conferta[n].	Lons. Sil. Sys. 688.	Benthall Edge.	*	.	.	.	.	.	.	*	.	.	.
Lonsdaleia Wenlockensis.	M'C. Pal. Fos. 34.	Wenlock.	.	.	.	.	*	.	.	.	.	.	.
Nebulipora Bowerbanki.	Edw. Br. Cor. 268.	Dudley, Benthall Edge.	.	.	3	4	*	.	.	.	.	.	.
,, explanata.	M'C. Pal. Fos. 23.	Coniston.	.	.	.	.	.	*	.	.	.	.	.
,, favulosa[o].	Phil. G. Sur. ii. 306.	Llan Mill.	.	.	.	2	.	.	.	.	.	.	.
,, lens.	M'C. Pal. Fos. 23.	Bala. Horderly.	.	.	.	.	.	**	.	.	.	.	.
,, papillata[p].	M'C. Pal. Fos. 24.	Dudley, Coniston.	.	.	.	.	*	*	.	.	.	.	.
Omphyma Murchisoni.	Edw. Br. Cor. 289.	Wenlock.	.	.	.	.	*	.	.	.	.	.	.
,, turbinata[q].	Lons. Sil. Sys. 690.	Dudley, Prolimoor.	*	*	5	4	*	*	.	*	*	.	*
Paleocyclas Fletcheri.	Edw. A. Mus. 205.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
,, porpita[r].	Edw. Br. Cor. 246.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
,, preacutus[s].	Lons. Sil. Sys. 693.	Dudley, Marloes Bay.	*	.	.	1	.	.	.	.	.	.	.
,, rugosus.	Edw. A. Mus. 206.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
Petraia æquisulcata.	M'C. Pal. Fos. 39.	Mulock, Ayrshire.	.	.	.	.	.	*	.	.	.	.	.
,, bina[t].	Lons. Sil. Sys. 692.	Downton, Marloes Bay.	*	*	5	4	.	*	.	***	.	.	**
,, elongata[u].	Phil. G. S. ii. 210.	May Hill, Tyrone.	.	.	8	3	.	*	*	.	.	.	*
,, pluriradialis[v].	Phil. Pal. Fos. 5.	Linton, Brashford.	.	.	.	.	*	.	.	.	.	.	.
,, rugosa[w].	Phil. Pal. Fos. 7.	Snowdon.	.	.	.	.	.	*	.	.	.	.	.
,, subduplicata[x].	M'C. Pal. Fos. 40.	Mulock, Ayrshire.	.	.	.	.	.	*	.	.	.	.	*
,, uniserialis[y].	M'C. Pal. Fos. 41.	Montgomeryshire.	.	.	.	.	.	*	.	.	.	.	.
,, zic-zac.	M'C. Sil. Fos. 60.	Ardaun.	.	.	.	.	.	.	.	*	.	.	.
Ptycophyllum patellarum[z].	Lons. Sil. Sys.	Malverns.	.	.	.	.	*	.	.	.	.	.	.
Pyritonema fasciculus.	M'C. Pal. Fos. 10.	Tregib, Llandeilo.	.	.	.	.	.	*	.	.	.	.	.
Sarcinula organum.	M'C. Pal. Fos. 37.	Dudley, Coniston.	.	.	.	.	*	*	.	.	.	.	.
Stenopora fibrosa[aa].	Lons. Sil. Sys. 683	Ludlow, Bala.	*	*	**	**	*	***	*	***	*	***	**
Strephodes Craigensis.	M'C. Pal. Fos. 30.	Girvan, Ayr.	.	.	.	.	.	*	.	.	.	.	.
,, gracilis.	M'C. Pal. Fos. 22.	Newtown Bushel.	.	.	.	*	.	.	.	.	.	.	.
,, plicatus[bb].	Sow. Sil. Sys. 691.	Malvern Hills.	*	.	.	.	.	.	.	.	.	.	*
,, pseudoceratites.	M'C. Pal. Fos. 30.	Dudley, Sedgley.	.	.	.	.	*	.	.	.	.	.	.
,, trochiformis.	M'C. Pal. Fos. 31.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
,, verniculoides.	M'C. Pal. Fos. 31.	Wenlock, Aymestry.	.	.	.	.	*	.	.	.	.	.	.
Stromatopora concentrica.	Lons. Sil. Sys. 680.	Dudley, Tramore.	*	.	2	3	*	.	*	.	*	*	*
,, nummulitissimus	Lons. Sil. Sys. 681.	Aymestry.	*	.	.	.	.	.	.	.	.	.	.
,, polymorpha.	Phil. Pal. Fos. 18.	Chudleigh, Kildare.	.	.	.	.	*	.	*	.	*	.	.

[a] Carophyllia flexuosa.
[b] Fav. aspera.
[c] Fav. polymorpha.
[d] Fav. Goldfussi.
[e] Petraia quadrata.
[f] Catenipora escharoides.
[g] Paleopora favosus.
[h] Porites inordinata.
[i] Porites pyriformis.
[j] Porites megastoma.
[k] Porites petalliformis.
[l] Paleopora subtilis.
[m] Porites tubulata.
[n] Monticularia conf.
[o] Favosites favulosa.
[p] Chætetes tuberculatus.
[q] Cyathophyllum turbinatum.
[r] Cyclolites numismalis.
[s] Cyclolites preacutus, Lons.
[t] Turbinolopsis bina.
[u] Turbinolopsis elongata.
[v] Turbinolopsis pluriradialis.
[w] Turbinolopsis rugosa.
[x] Petr. crenulata.
[y] Petr. gracilis.
[z] Strombodes plicatum.
[aa] Favosites fibrosa.
[bb] Strombodes plicatus.

Name.	Authority.	Locality.	Mur. Upper.	Mur. Lower.	Phil. Upper.	Phil. Lower.	Sedg. Upper.	Sedg. Lower.	Irish, M'Coy. Tyrone.	Irish, M'Coy. Galway.	Irish, M'Coy. Kild. Dubl.	Irish, M'Coy. W. W. W.	Irish, M'Coy. Kerry.
ZOOPHYTA—*continued.*													
Stromatopora striatella[a].	Lons. Sil. Sys. 680.	Aymestry.	*	.	.	.	.	.	*	.	*	*	**
Strombodes Wenlockensis.	M'C. Pal. Fos. 34.	Wenlock.	.	.	.	.	*	.	.	.	.	.	.
Syringopora bifurcata[b].	Lons. Sil. Sys. 685.	Dudley.	*	.	2	.	*	.	.	.	.	.	.
„ cæspitosa.	Lons. Sil. Sys. 685.	Wenlock, Woolhope.	*	.	1	.	.	.	.	.	.	.	.
„ fascicularis[c].	Linn. Sil. Sys. 676.	Benthall Edge, Usk.	*	.	1	.	.	.	.	*	.	.	.
„ Lonsdaleiana[d].	M'C. Sil. Fos. 65.	Portrane.	.	.	.	.	*	.	.	.	*	.	.
„ reticulata.	Lons. Sil. Sys. 684.	Gleedon Hill, Usk.	*	.	1	.	.	.	.	.	.	.	.
„ serpens[e].	Lons. Sil. Sys. 675.	Dudley.	*	.	1	.	.	.	.	.	.	.	*
Thecia Grayana.	Edw. Br. Cor. 279.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
„ Swindernana[f].	Lons. Sil. Sys. 687.	Aymestry.	*	.	3	1	.	.	.	.	.	.	.
Zaphrentis lata.	M'C. Pal. Fos. 28.	Wenlock.	.	.	.	.	*	.	.	.	.	.	.
ECHINODERMATA.													
Actinocrinus pulcher.	Salt. P. F. App. 1.	Kendal.	.	.	.	.	*	*	.	.	.	.	.
„ retiarius.	Phil. Sil. Sys. 674.	Dudley.	*	.	.	.	.	.	.	.	.	.	.
„ simplex.	Phil. Sil. Sys. 672.	Dudley.	*	.	.	.	.	.	.	.	.	.	.
„ tenuistriatus.	Phil. Pal. Fos. 31.	Linton.	.	.	.	.	*	.	.	.	.	.	.
Agelacrinus Buchianus.	Forbes, Sil. 207.	Yspetty Evan.	.	.	.	.	.	*	.	.	.	.	.
Apiocystites pentremitoides.	Forbes, Sil. 245.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
Crotalocrinus rugosus[g].	Miller, Sil. 247.	Dudley, Usk.	*	.	3	.	*	.	.	.	.	.	.
Cyathocrinus arthriticus.	Phil. Sil. Sys. 674.	Dudley.	*	.	.	.	*	.	.	.	.	.	.
„ capillaris[h].	Phil. Sil. Sys. 671.	Dudley.	*	.	.	.	.	.	.	.	.	.	.
„ Dudleyensis[i].	Aust. A. N. H. 195.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
„ goniodactylus.	Phil. Sil. Sys. 671.	Dudley.	*	.	.	.	.	.	.	.	.	.	.
„ pyriformis.	Phil. Sil. Sys. 672.	Dudley, Freshwater.	*	.	.	*	.	.	.	.	.	.	.
„ variabilis.	Phil. Pal. Fos. 32.	Ilfracombe.	.	.	.	.	*	.	.	.	.	.	.
Dimirocrinus decadactylus.	Phil. Sil. Sys. 674.	Dudley.	*	.	.	.	.	.	.	.	.	.	.
„ icosydactylus.	Phil. Sil. Sys. 674.	Marloes Bay.	*	.	.	1	.	.	.	.	.	.	.
Echinoerinus armatus.	Forbes, Sil. 245.	Walsall.	.	.	.	.	*	.	.	.	.	.	.
„ baccatus.	Forbes, Sil. 245.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
Echinospherites arachnoideus.	Forbes, G. Sur. ii. 518	Bala.	.	.	.	1	.	*	.	.	.	.	.
„ aurantium[j].	M'C. Sil. Fos. 59.	Carrickadaggan.	.	.	.	1	.	.	.	.	.	*	.
„ Balticus.	Eichw. Salt. Sil. 207.	Bala.	.	.	.	1	.	*	.	.	.	.	.
„ Davisii[k].	M'C. Pal. Fos. 61.	Coniston, Ys-patty-Evan.	.	.	.	.	.	*	.	.	.	.	.
„ granatus[l].	Wahl. Salt. Sil. 207.	Kildare.	.	.	.	1	.	*	.	.	.	.	.
„ granulatus.	M'C. Sil. Fos. 59.	Carrickadaggan.	.	.	.	.	.	*	.	.	.	**	.
Enallocrinus punctatus.	His. Leth. Suec. 89.	?	.	.	.	.	*	.	.	.	.	.	.
Eucalyptocrinus decorus[m].	Phil. Sil. Sys. 672.	Dudley.	*	.	1	.	*	.	.	.	.	.	.
„ granulatus.	Lewis, G. Jour. t. 21.	Walsall.	.	.	.	.	*	.	.	.	.	.	.
„ polydactylus.	M'C. Pal. Fos. 58.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
Glyptocrinus basalis.	M'C. Pal. Fos. 57.	Montgomeryshire.	.	.	.	.	.	*	.	.	.	.	*
„ expansus.	Phil. Sil. Sys. 674.	Dudley.	*	.	.	.	.	.	.	.	.	.	.
„ lævis[n].	Port. G. Rep. 345.	Desertcreat.	.	.	.	.	.	.	*	.	.	.	.
Hemicosmites oblongus.	Forbes, G. Sur. ii. 511	Sholes Hook.	.	.	.	1	.	*	.	.	.	.	.
„ pyriformis.	Buch. G. Sur. ii. 511.	Sholes Hook.	.	.	.	.	.	*	.	.	.	.	.
„ squamosus.	Forbes, G. Sur. 510.	Bala.	.	.	.	.	.	*	.	.	.	.	.
Ichthyocrinus pyriformis.	Phil. Sil. Sys. 672.	Dudley.	*	.	.	.	.	.	.	.	.	.	.
Ischadites Konigii.	Murch. Sil. Sys. 697.	Ludlow.	*	.	.	.	.	.	.	.	.	.	.
Lepidaster Grayi.	Forb. G. Sur. Dec. 3.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
Marsupiocrinus cælatus.	Phil. Sil. Sys. 672.	Dudley.	*	.	.	.	.	.	.	.	.	.	.
Palæaster asperrimus.	Salt. A. N. H. xx. 325.	Welchpool.	.	.	.	.	.	*	.	.	.	.	.
„ coronella.	Salt. A. N. H. xx. 326.	Gunwick Mill.	.	.	.	.	.	*	.	.	.	.	.
„ hirudo.[o]	Forb. A. N. H. xx. 326	Potter's Fell.	.	.	.	.	*	.	.	.	.	.	.
„ obtusus.	Forb. A. N. H. xx. 326	Kendall	.	.	.	.	*	.	.	.	.	.	.
„ Ruthveni[p].	Forb. A. N. H. xx. 326	Westmoreland.	.	.	.	.	*	.	.	.	.	.	.
Palæchinus Phillipsiæ.	Forbes, G. Sur. ii. 384	Malvern.	.	.	.	.	*	.	.	.	.	.	.
Palæocoma Colvini.	Salt. A. N. H. xx. 328.	Leintwardine.	.	.	.	.	*	.	.	.	.	.	.

[a] Strom. concentrica.
[b] Syr. reticulata.
[c] Aulopora tubæformis.
[d] Syr. reticulata.
[e] Aulopora serpens.
[f] Porites expatiata.
[g] Cyathocrinus rugosus.
[h] Poteriocrinus radiatus.
[i] Poteriocrinus Dudleyensis.
[j] Ech. granulatus.
[k] Caryocystites Davisii.
[l] Sphæronites testudinarius.
[m] Hypanthocrinus decorus.
[n] Trochocrinus lævis.
[o] Uraster hirudo.
[p] Uraster Ruthveni.

Name.	Authority.	Locality.	Mur. Upper.	Mur. Lower.	Phil. Upper.	Phil. Lower.	Sedg. Upper.	Sedg. Lower.	Irish, M'Coy. Tyrone.	Irish, M'Coy. Galway.	Irish, M'Coy. Kild. Dubl.	Irish, M'Coy. W. W. W.	Irish, M'Coy. Kerry.
ECHINODERMATA—*cont.*													
Palæocoma cygnipes.	Salt.A.N.H.xx.329.	Leintwardine.	.	.	.	.	*	.	.	.	.	.	.
„ Marstoni.	Salt.A.N.H.xx.328.	Leintwardine.	.	.	.	.	*	.	.	.	.	.	.
„ vermiformis[a].	Salt.A.N.H.xx.329.	Leintwardine.	.	.	.	.	*	.	.	.	.	.	.
Palæodiscus ferox.	Salt.A.N.H.xx.333.	Leintwardine.	.	.	.	.	*	.	.	.	.	.	.
Palasterina primæva.	Forb.A.N.H.xx.327	Leintwardine.	.	.	.	.	*	.	.	.	.	.	.
Periechocrinus articulosus.	Aust.A.N.H.'43,204	Dudley, Curryculenagh.	.	.	.	.	*	.	.	.	.	.	.
„ moniliformis[b].	Mill. Sil. Sys. 672.	Dudley.	*	.	3	2	*	*	.	.	.	.	*
Pisocrinus ornatus.	Kon.Bull.A.R.iv.93		.	.	.	.	*	.	.	.	.	.	.
„ pilula.	Kon.Bull.A.R.iv.93		.	.	.	.	*	.	.	.	.	.	.
Platycrinus retiarius[c].	Phil. Sil. Sys. 674.	Dudley.	*	.	.	.	.	.	.	.	.	.	.
Pleurocystites Rugeri[d].	Salt. Sil. 229.	Llandovery.	.	.	.	.	*	*	.	.	.	.	.
Poteriocrinus Dudleyensis.	Aust.A.N.H.'43,195	Dudley.	.	.	.	.	*	.	.	.	.	.	.
Protaster leptosoma.	Salt.A.N.H.xx.331.	Leintwardine.	.	.	.	.	*	.	.	.	.	.	.
„ Miltoni.	Salt. Sil. 141.	Leintwardine.	.	.	.	.	*	.	.	.	.	.	.
„ Salteri.	Sedg. G. J. i. 20.	Corrig-y-Druiddion.	.	.	.	.	.	*	.	.	.	.	.
„ Sedgwickii.	Forb. Sil. 249.	Underbarrow.	.	.	.	.	*	.	.	.	.	.	.
Prunocystites Fletcheri.	Forb. M.G.S. ii. 504.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
Pseudocrinites bifasciatus.	Pear. M.G.S. ii. 501.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
„ magnificus.	Forb. M.G.S. ii, 501.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
„ oblongus.	Forb. M.G.S. ii. 499.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
„ quadrifasciatus.	Pearce, Sil. 245.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
Rhodocrinus quinquangularis.	Mill. Crin. 109.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
Rhopalocoma pyrotechnica	Salt.A.N.H.xx. 329.	Leintwardine.	.	.	.	.	*	.	.	.	.	.	.
Sphæronites Litchi[e].	Forb. M.G.S. ii. 514.	Sholes Hook.	.	.	.	*	.	*	.	.	.	.	.
„ munitus[f].	Forb. M.G.S. ii. 515.	Reulas.	.	.	.	.	.	*	.	.	.	.	.
„ punctatus[g].	Forb. M.G.S. ii. 518.	Reulas.	.	.	.	.	.	*	.	.	.	.	.
„ pyriformis[h].	Forb. M.G.S. ii. 515.	Reulas.	.	.	.	.	.	*	.	.	.	.	.
Taxocrinus Orbignyi[i].	M'C. Pal. Fos. 53.	Underbarrow.	.	.	.	.	*	.	.	.	.	.	.
„ tesseracontadactylus[j].	His. Leth. Suec. 90.	Gottland.	.	.	.	.	*	.	.	.	.	.	.
„ tuberculatus[k].	Mill. Sil. xiv. 5.	Dudley.	*	.	.	.	.	.	.	.	.	.	.
Tetragonis Danbyi.	M'C. Pal. Fos. 62.	Brigsteer.	.	.	.	.	*	.	.	.	.	.	.
Tetramerocrinus formosus[l].	Aust.A.N.H.'43,203	Dudley.	.	.	.	.	*	.	.	.	.	.	.
Uraster primævus.	Forbes, G. Sur.	Kendal.	.	.	.	.	*	.	.	.	.	.	.
ARTICULATA.													
Chondrites acutangulis.	M'C.Pal.Fos. Pl.1A.	Low Fell, Whitless.	.	.	.	.	.	*	.	.	.	.	.
„ informis.	M'C. Pal. Fos. 1A.	Low Fell, Whitless.	.	.	.	.	.	*	.	.	.	.	.
Cornulites serpularius.	Sch.Mur.S.Sys. 627.	Malverns, Dudley.	*	.	5	4	*	.	.	.	.	.	*
Crossopodia lata.	M'C. Pal. Fos. 130.	Llandeilo.	.	.	.	.	.	*	.	.	.	.	.
„ Scotica.	M'C. Pal. Fos. 130.	Inverleithen.	.	.	.	.	.	*	.	.	.	.	.
Lumbricaria antiqua.	Port. G. Rep. 361.	Bardahessia.	.	.	.	.	.	.	*	.	.	.	.
„ gregaria.	Port. G. Rep. 361.	Bardahessia.	.	.	.	.	.	.	*	.	.	.	.
Myrianites Macleayi.	Murch. Sil.Sys. 700.	Llampeter.	.	*	.	1	.	*	.	.	.	.	.
„ tenuis.	M'C. Pal. Fos. 130.	Grieston-on-Tweed.	.	.	.	.	.	*	.	.	.	.	.
Nemertites Ollivantii.	Mur. Sil. Sys. 701.	Llampeter.	.	*	.	1	.	*	.	.	.	.	.
Nereites Cambrensis.	Mur. Sil. Sys. 700.	Llampeter.	.	*	.	1	.	*	.	.	.	.	.
„ multiformis.	Hark. G. J. xi. 476.	Barlae, Kirkcudbright.	.	.	.	.	.	*	.	.	.	.	.
„ Sedgwickii.	Mur. Sil. Sys. 700.	Llampeter.	.	*	.	1	.	*	.	.	.	.	.
Serpulites curtus.	Salt. G. Sur. ii. 333.	Collins Green.	.	.	2	.	*	.	.	.	.	.	.
„ dispar.	Salt. P. F. App. i.	Benson Knot.	.	.	.	.	*	**	.	.	.	.	.
„ longissimus.	Mur. Sil. Sys. 608.	Ludlow, Aymestry.	*	.	5	1	*	.	.	.	.	.	*
„ Mac Cullochii.	Salt.		.	.	.	.	.	*	.	.	.	.	.
„ perversus.	M'C. G. Soc. ix. 15.	Whitfield.	.	.	.	.	*	.	.	.	.	.	.
Spirorbis Lewisii.	Sow. Sil. Sys. 616.	Dudley, Galway.	*	.	.	.	.	*	.	**	*	.	*
Tentaculites Anglicus[m].	Mur. Sil. Sys. 643.	Hope Mill, Shelve.	.	*	5	4	.	*	.	***	*	*	.
„ ornatus.	Sow. Sil. Sys. 628.	Dudley, Ayr.	*	.	3	1	.	1	.	.	.	.	.
„ tenuis.	Sow. Sil. Sys. 613.	Usk, Benson Knot.	*	.	3	.	*	.	.	.	.	.	*
Trachyderma coriacea.	Phil. G. Sur. ii. 230.	Abberley, Hill Side.	.	.	1	.	.	.	.	.	.	.	.

[a] Bdellacoma ver.
[b] Actinocrinus moniliformis.
[c] Actinocrinites retiarius.
[d] Glyptocystites rugeri.
[e] Caryocistites Litchi.
[f] Caryocistites munitus.
[g] Echinospherites punctatus.
[h] Caryocistites pyriformis.
[i] Cyathocrinus O.
[j] Cyathocrinus simplex.
[k] Cyathocrinus tuberculatus.
[l] Asterias primæva.
[m] Tentaculites annulatus.

Name.	Authority.	Locality.	Mur.		Phil.		Sedg.		Irish, M'Coy.				
			Upper.	Lower.	Upper.	Lower.	Upper.	Lower.	Tyrone.	Galway.	Kild. Dubl.	W. W. W.	Kerry.
ARTICULATA—*continued.*													
Trachyderma lævis.	M'C. Pal. Fos. 133.	Acton Scott.	.	.	.	.	.	1	.	.	.	.	.
" squamosa.	Phil. G. Sur. ii. 230.	Gorstley, Kendal.	.	.	.	.	*	.	.	.	.	.	.
CRUSTACEA.													
Acidaspis Barrandii.	Salter, Sil. 261.	Abberley.	.	.	.	.	*	.	.	.	.	.	.
" bispinosus.	M'C. Sil. Fos. 45.	Dudley, Kildare.	.	.	1	.	*	.	.	.	*	*	.
" Brightii.	Mur. Sil. Sys. 658.	Dudley, Malverns.	*	.	4	2	*	*	.	.	.	.	.
" callipareos.	Thom.G.J. xiii. 208.	Mullock Hill, Ayr.	.	.	.	.	.	*	.	.	.	.	.
" Caractaci.	Salt. G. J. xiii. 211.	Gretton, Shropshire.	.	.	.	.	.	*	.	.	.	.	.
" coronatus.	Salt. G. J. xiii. 210.	Ludlow.	.	.	.	.	*	.	.	.	.	*	.
" Dama.	Fletch. & S. Mor. 99.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
" dumetosa.	Fletch. & S. Mor. 99.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
" hystrix.	Thom.G.J. xiii. 207.	Pinwhapple, Ayr.	.	.	.	.	.	*	.	.	.	.	.
" Jamesii.	Salt.G.Sur.D. 7, t.6.	Wexford, Waterford.	.	.	.	.	.	.	.	.	.	*	*
" Lalage.	Thom.G.J. xiii. 206.	Pinwhapple.	.	.	.	.	.	*	.	.	.	.	.
" quinquispinosa.	Fl. & Salt. Mor. C. 99.	Dudley.	.	.	.	.	.	.	.	.	.	.	.
" unica.	Thom.G.J. xiii. 209.	Pinwhapple, Ayr.	.	.	.	.	.	*	.	.	.	.	.
Æglina binodosa.	Salt. Sil. 50.		.	.	.	.	.	*	.	.	.	.	.
" grandis.	Salt. Sil. 53.		.	.	.	.	.	*	.	.	.	.	.
" major.	Salt.G.Sur.D. vii. 4.	Anglesea.	.	.	.	.	.	*	.	.	.	.	.
" mirabilis.	Forbes, Sil. 184.	Portrane.	.	.	.	.	.	.	.	.	*	.	.
Agnostus limbatus.[a]	Salter, MSS.	Bala, Wexford.	.	.	.	.	.	1	.	.	.	*	.
" M'Coyii.	Salter, MSS.	Builth.	.	.	.	.	.	1	.	.	.	.	.
" pisiformis[b].	Mur. Sil. Sys. 664.	Builth.	.	*	.	2	.	*	.	.	.	.	.
" trinodus[c].	Salt. G. Sur. ii. 235.	Bala, Greenville.	.	.	.	1	.	1	.	.	.	*	.
Amphion pseudoarticulatus	Port. G. R. 291.	Tramore.	.	.	.	.	.	.	*	.	.	*	.
Amphyx mamillatus[d].	Port. G. R. 261.	Tramore, Newtown Head.	.	.	.	.	.	.	*	.	.	**	.
" nudus.	Murch. S. S. 660.	Builth.	.	*	.	1	.	*	.	.	.	.	.
" parvulus.	Forbes, G. Sur. 350.	Ludlow.	.	.	.	.	*	.	.	.	.	.	.
" rostratus.	Port. G. R. 260.	Tirnaskea.	.	.	.	.	.	.	*	.	.	.	.
" tumidus.	Forb.G.Sur. Dec. 2.	Bala.	.	.	1	.	.	*	.	.	.	.	.
Angelina Sedgwickii.	Salt. Sil. 53.		.	.	.	.	.	*	.	.	.	.	.
" subarmiata.	Salt. Sil. 53.	Tremadoc.	.	.	.	.	.	*	.	.	.	.	.
Asaphus gigas[e].	Port. G. R. 295.	Bardahessia, Tremadoc.	.	.	.	.	.	*	*	.	.	*	.
" lævicepa.	Port. G. R. 299.	Desertcreat.	.	.	.	.	.	.	*	.	.	.	.
" laticostatus[f].	M'C. P. F. 170.	Bala, Builth.	.	.	.	.	.	*	.	.	.	.	.
" Powisii[g].	Mur. Sil. Sys. 661.	Berwyns, Slieveroe.	.	*	.	.	.	**	.	.	.	*	.
" rectifrons[h].	Port. G. Rep. 298.	Tirnaskea, Tramore.	.	.	.	.	.	.	*	.	.	*	.
" tyrannus.	Mur. Sil. Sys. 662.	Goldengrove.	.	*	1	2	.	**	.	.	.	.	.
Beyrichia affinis.	Jones, A. N. H. 2, xvi. 170.	Tramore.	.	.	.	.	.	*	.	.	.	.	.
" Barrandiana.	Jones, A.N.H. xvi. 171.	Beddgelert.	.	.	.	.	.	*	.	.	.	.	.
" bicornis.	Jones, A.N.H. xvi. 173.	Harnage, Shrewsbury.	.	.	.	.	.	*	.	.	.	.	.
" complicata.	Salt. G. Sur. ii. 352.	Llan Mill.	.	.	.	2	.	**	.	.	.	*	.
" Klœdeni[i].	M'C. Pal. Fos. 135.	Llanfair, Welchpool.	.	.	4	2	*	.	.	*	.	.	*
" seminulum.	Jones, A.N.H. xvi. 173.	Town Hill, Montgomery.	.	.	.	.	*	.	.	.	.	.	.
" siliqua.	Jones, A.N.H. xvii. 90.		.	.	.	.	*	.	.	.	.	.	.
" strangulata.	Salt. Pal. Fos. A. 2.	Coniston.	.	.	.	.	.	*	.	.	.	.	.
Bronteus Hibernicus[j].	Port. G. Rep. 274.	Tirnaskea.	.	.	.	.	.	.	*	*	*	.	.
" laticauda[k].	M'Coy, S. F. 52.	Wenlock, Uggool.	.	.	.	.	*	.	.	*	.	.	.
Calymene Blumenbachii.	Mur. Sil. Sys. 653.	Dudley, Bala.	*	.	6	3	*	*	*	*	*	*	*
" brevicapitata[l].	Port. G. Rep. 286.	Bala, Tirnaskea.	.	.	.	2	.	**	*	*	.	.	.
" duplicata.	Mur. Sil. Sys. 661.	Wilmington, Builth.	.	*	.	2	.	*	.	*	.	.	.
" obtusa[m].	M'C. Sil. Fos. 54.	Kildare.	.	.	.	.	.	.	.	.	*	*	.
" parvifrons.	Salt. P. Fos. App. 3.	Merionethshire.	.	.	.	.	.	*	.	.	.	.	.
" tuberculosa.	Mur. Sil. Sys. 656.	Dudley, Usk.	*	.	1	.	*	.	.	.	.	.	.

[a] Agnostus trinodus.
[b] Deplorhina triplicata.
[c] Trinodus agnostiformis.
[d] Amp. Austini.
[e] Isotelus gigas.
[f] Ogygia radiata.
[g] Isotelus Powisii.
[h] Isotelus rectifrons.
[i] Beyrichia gibba.
[j] Lichas Hibernicus.
[k] Bront. signatus.
[l] Calymene Blumenbachii.
[m] Otarion obtusa.

Name.	Authority.	Locality.	Mur.		Phil.		Sedg.		Irish, M'Coy.				
			Upper.	Lower.	Upper.	Lower.	Upper.	Lower.	Tyrone.	Galway.	Kild. Dubl.	W. W. W.	Kerry.
CRUSTACEA—*continued.*													
Ceratiocaris ellipticus[a].	M'C. Pal. Fos. 137.	Benson Knot.	.	.	.	.	*	.	.	.	.	.	.
„ inornatus.	M'C. Pal. Fos. 137.	Benson Knot.	.	.	.	.	*	.	.	.	.	.	.
„ leptodactylus.	M'C. Pal. Fos. 175.	Leintwardine.	.	.	.	.	*	.	.	.	.	.	.
„ solenoides.	M'C. Pal. Fos. 138.	Benson Knot.	.	.	.	.	*	.	.	.	.	.	.
„ Murchisoni.	Ag. xix. i. 2.	Ludlow	.	.	.	.	*	.	.	.	.	.	.
„ papilio.	Salt. Sil. 262.	Ludlow.	.	.	.	.	*	.	.	.	.	.	.
Cheirurus bimucronatus[b].	Mur. Sil. Sys.	Kildare, Dudley.	*	.	1	2	.	.	*	.	*	.	*
„ cancrurus.	Salt. G. Sur. Dec. 7.	Kildare.	.	.	.	.	.	.	.	.	*	.	.
„ clavifrons[c].	Dalm. Sil. 225.	Bala, Kildare.	.	.	.	1	.	**	.	.	*	.	.
„ gelasinosus[d].	M'C. S. Fos. 44.	Kildare, Ayr.	.	.	.	.	.	*	*	.	*	.	.
„ octolobatus.	M'C. P. Fos. 154.	Rhiwlas, Bala.	.	.	.	.	.	*	.	.	.	.	.
„ Sedgwickii.	M'C. P. Fos. 155.	Builth.	.	.	.	.	.	*	.	.	.	.	.
Cybele rugosa[e].	Port. G. R. 302.	Coniston.	.	.	.	.	.	.	*	.	.	*	.
„ verrucosa[f].	M'C. P. Fos. 156.	Bala, Alt yr Anker.	.	.	.	2	.	*	.	.	*	*	.
Cyphaspis megalops[g].	M'C. S. Fos. 54.	Dudley, Bala.	*	.	.	.	.	.	.	**	*	.	.
„ pygmæus.	Salt. G. Sur. Dec. 7.	Eastnor Castle.	.	.	.	.	*	.	.	.	.	.	.
Cyphoniscus socialis.	Salt. G. S Dec. 7.	Kildare.	.	.	.	.	.	*	.	.	*	.	.
Cythere phaseolus.	M'Coy.	Kildare.	.	.	.	.	.	.	.	.	*	.	.
„ umbonata.	Salt. Pal. Fos. 138.	Bala, Conway Falls.	.	.	.	.	.	*	.	.	.	.	.
Cytheropsis Aldensis.	M'C. Pal. Fos. Pl. l. L.	Aldens, Ayr.	.	.	.	.	.	*	.	.	.	.	.
Deiphon Forbesii.	Bar. Sil. Sys. Boh. 814	Dudley.	*	.	.	.	.	.	.	.	.	.	.
Dythyrocaris aptychoides.	Salt. G. J. viii. 391.	Dumfriesshire.	.	.	.	.	.	*	.	.	.	.	.
Eccoptochile Sedgwickii.	M'C. Pal. Fos. 155.	Builth.	.	.	.	.	.	*	.	.	.	.	.
Encrinurus baccatus.	Port. G. Rep. 262.	Desertcreat.	.	.	.	.	.	.	*	.	.	.	.
„ multisegmentatus[h].	Port. G. Rep. 291.	Killey, Tirnaskea.	.	.	.	.	.	*	*	.	.	.	.
„ punctatus[i].	Mur. Sil. Sys. 655.	Ardaun, Ferriters.	.	*	5	4	*	*	.	**	.	*	*
„ sexcostatus[j].	Salt. G. S. Dec. 7.	Bala.	.	.	.	1	.	*	.	.	.	*	*
„ variolaris[k],	Mur. Sil. Sys. 655.	Dudley, Wenlock Edge.	*	.	3	2	*	.	.	*	.	.	*
Eurypterus abbreviatus.	Salt. G. Jour. xv.	Kington.	.	.	.	.	*	.	.	.	.	.	.
„ acuminatus.	Salt. G. Jour. xv.	Ludlow.	.	.	.	.	*	.	.	.	.	.	.
„ cephalaspis[l].	Salt. P. Fos. App. 5.	Kendal.	.	.	.	.	*	.	.	.	.	.	.
„ chartarius.	Salt. G. Jour. xv.	Lesmahago.	.	.	.	.	*	.	.	.	.	.	.
„ lanceolatus.	Salt. G. Sur. Dec. 10.	Lesmahago.	.	.	.	.	*	.	.	.	.	.	.
„ linearis.	Salt. G. Jour. xv.	Ludlow, Kington.	.	.	.	.	*	.	.	.	.	.	.
„ megalops.	Salt. G. Jour. xv.	Ludlow.	.	.	.	.	*	.	.	.	.	.	.
„ pygmæus.	Salt. Sil. 266.	Ludlow, Kington.	.	.	.	.	*	.	.	.	.	.	.
„ Symondsii.	Salt. G. Jour. xv.	Rowleston, Brecon.	.	.	.	.	*	.	.	.	.	.	.
Harpes Doranni.	Port. G. Rep. 267.	Bardahessia.	.	.	.	.	.	.	*	.	.	.	.
„ Flannagani.	Port. G. Rep. 268.	Bardahessia.	.	.	.	.	.	.	*	.	.	*	.
Homalonotus bisulcatus.	Salt. P. F. Ap. v.	Acton Scott.	.	.	.	.	.	*	.	.	.	*	.
„ delphinocephalus	Sow. Sil. Sys. 651.	Dudley Castle.	*	.	.	.	.	.	.	.	.	.	.
„ Herschelli.	Mur. Sil. Sys. 652.	Meadsfoot Sands.	*	.	.	.	*	.	.	.	.	.	.
„ Knightii[m].	Mur. Sil. Sys. 651.	Ludlow, Kendal.	*	.	2	3	*	*	.	.	.	.	.
„ rudis.	Salt. Pal. Fos. 168.	Capel Garmon.	.	.	.	.	.	*	.	.	.	.	.
„ vulcani[n].	Mur. Sil. Sys. 663.	Corndon Hill.	.	*	.	.	.	.	.	.	.	.	.
Hymenocaris vermicauda.	Salt. Sil. 45.	Ffestiniog.	.	.	.	.	.	*	.	.	.	.	.
Illænus Barriensis.	Mur. Sil. Sys. 656.	Hay Head Limeworks.	*	.	.	2	.	.	.	.	.	.	.
„ Bowmanni[o].	Salt. G. Sur. Dec. 2.	Llandilo, Kildare.	.	.	.	2	.	*	*	*	*	.	*
„ Davisii.	Salt. G. Sur. 171.	Llwyn y Ci, Bala.	.	.	.	.	.	*	.	.	.	.	.
„ Murchisoni[p].	M'C. Pal. Fos. 172.	Llandilo, Coniston.	.	.	.	1	.	*	.	.	.	.	.
„ ocularis.	Salt. G. Sur. Dec. 2.	Llandilo, Kildare.	.	.	.	.	.	*	.	.	*	.	.
„ perovalis.	Mur. Sil. Sys. 661.	Corndon, Kildare.	.	*	.	.	.	.	.	.	*	.	.
„ Portlockii.	Salt. G. Sur. Dec. 2.	Desertcreat.	.	.	.	.	.	.	*	.	.	.	.
Leptochiles leptodactylus.	M'C. Pal. Fos. 175.	Leintwardine.	.	.	.	.	*	.	.	.	.	.	.
„ Murchisonii.	Ag. Mur. S. Sys. 607.	Ludlow.	*	.	.	.	.	.	.	.	.	.	.
Leperditia marginata.	Keys. A. N. H. xvii. 91	Livonia.	.	.	.	.	*	.	.	.	.	.	.
„ Solvensis.	Jones, A. N. H. xvii. 95.	Upper Solva.	.	.	.	.	.	*	.	.	.	.	.
Lichas Anglicus[q].	M'Coy, P. F. 151.	Dudley.	.	.	.	.	*	.	.	.	.	.	.

[a] Leptocheles ellipticus.
[b] Paradoxides bimucronatus.
[c] Sphærerochus juvenis.
[d] Amphion gelasinosus.
[e] Ogygia rugosa.
[f] Zethus atractopyge.
[g] Harpidella megalops.
[h] Amphion mult.
[i] Cybele punctata.
[j] Cybele sexcostata.
[k] Calymene variolaris.
[l] Homolonatus ceph.
[m] Hom. Ludensis.
[n] Asaphus vulcani.
[o] Illænus centrotus.
[p] Illænus Rosenbergi.
[q] Arges Anglicus.

Name.	Authority.	Locality.	Mur. Upper.	Mur. Lower.	Phil. Upper.	Phil. Lower.	Sedg. Upper.	Sedg. Lower.	Irish, M'Coy. Tyrone.	Galway.	Kild. Dubl.	W. W. W.	Kerry.
CRUSTACEA—*continued.*													
Lichas Barrandii.	Fletch. Sil. 260.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
„ Grayii.	Fletch. G. J. vi. 237.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
„ hirsutus.	Fletch. G. J. vi. 236.	Dudley.	.	.	.	.	*	.	.	.	*	.	.
„ laciniatus.	Dal. M'C. P.F.Ap.4.	Coniston.	.	.	.	.	.	*	.	.	.	.	.
„ laxatus[a].	M'C. Sil. Fos. 51.	Wexford, Bala.	.	.	.	2	.	*	.	.	*	**	.
„ nodulosus[b].	Salter, P. F. 15.	Pont-y-Glyn.	.	.	.	.	.	*	.	.	.	.	.
„ Salteri.	Fletch. G.J. vi. 237.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
„ verrucosus.	Salt. M. G. ii. 340.	May Hill.	.	.	1	.	.	.	.	.	.	.	.
Ogygia Buchii[c].	Mur. Sil. Sys. 662.	Llandilo, Tirnaskea.	.	*	.	2	.	*	*	.	.	.	.
„ Portlockii.	Salter, Sil. 55.	Newtown Head.	.	.	.	1	.	*	*	.	.	*	.
„ scutatrix.	Salt. Sil. 53.		.	.	.	.	.	*	.	.	.	.	.
„ Selwynii.	Salt. Sil. 53.		.	.	.	.	.	*	.	.	.	.	.
Olænus alatus.	Beck. Aug. Pt. 1.		.	.	.	.	.	*	.	.	.	.	.
„ bisulcatus.	Phil.M.G.Sur. ii.239	Malvern.	.	.	1	.	.	.	.	.	.	.	.
„ humilis.	Phil. G. Sur. ii. 239.	Malvern.	.	.	1	.	.	.	.	.	.	.	.
„ micrurus.	Salter,G.Sur.Dec.2.	Tremadoc.	.	.	.	.	.	*	.	.	.	.	.
„ scarabæoides[d].	Salt.Br.Ass.1852, 58	Malvern.	.	.	1	.	.	*	.	.	.	.	.
Paradoxides Forchammeri.	Salt.Br.Ass.1852, 57	North Wales.	.	.	.	.	.	*	.	.	.	.	.
Phacops alifrons.	Salt.Pal.Fos.App.ii.	Caernarvon.	.	.	.	.	.	**	.	.	.	.	.
„ amphora.	Salt.G.Sur.D.vii.12.	Grug, Llandilo.	.	.	.	.	.	*	.	.	.	.	.
„ apiculatus[e].	M'C. Pal. Fos. 162.	Bala, Llansantfraid.	.	.	.	.	.	**	.	.	.	.	.
„ Brongniartii.	Port. G. Rep. 282.	Bardahissia.	.	.	.	.	.	.	*	.	*	*	.
„ caudatus[f].	Mur. Sil. Sys. 654.	Usk, Llandilo.	*	.	6	3	*	*	.	.	.	.	*
„ conophthalmus.	Mur. S.	Horderly.	.	*	.	.	.	.	.	.	.	.	.
„ Dalmanni[g].	Port. G. Rep. 282.	Tyrone, Greenville.	.	.	.	2	.	.	*	.	.	*	.
„ Downingiæ[h].	Mur. Sil. Sys. 655.	Dudley, Llanwrst.	*	.	2	3	*	*	.	.	.	.	*
„ Jamesii.	Port. G. Rep. 283.	Knockmahon.	.	.	.	.	.	.	*	.	.	*	.
„ Jukesii.	Salt.G.Sur.Dec.7,11	Bala, Gelli Grin.	.	.	.	.	.	*	.	.	.	.	.
„ longicaudatus[i].	Sow. Sil. Sys. 656.	Malverns.	*	.	3	1	*	*	.	.	.	.	.
„ mucronatus.	Salt. G. Sur. Dec. 7.	Bala.	.	.	.	.	.	*	.	.	.	.	.
„ obtusicaudatus[j].	Salt. G. Sur. Dec. 7.	Coldwell.	.	.	.	.	.	*	.	.	.	.	.
„ Stokesii.	Salt. G. Sur. ii. 240.	Dudley, Ayr.	.	.	1	1	*	*	.	*	.	.	*
„ sublævis[k].	M'C. Sil. Fos. 51.	Ardaun.	.	.	.	.	.	.	.	*	.	.	.
„ truncatocaudatus[l].	Port. G. Rep. 281.	Coniston, Killey.	.	.	.	.	.	*	***	.	.	*	.
„ Weaveri.	Sal. G. Sur. D. 2, 7.	Tortworth.	.	.	.	.	.	*	.	.	.	.	.
Proetus latifrons[m].	M'C. Sil. Fos. 49.	Kendal, Uggool.	.	.	1	1	*	.	.	*	.	.	*
„ Stokesii[n].	Mur. Sil. Sys. 656.	Dudley.	*	.	2	1	*	.	.	.	.	.	.
Pterygotus acuminatus.	Salt. Sil. 168.	Lesmahago.	.	.	.	.	*	.	.	.	.	.	.
„ Anglicus.	Ag. Pois. Fos. p. 20.	Balruddery Den, Perth.	.	.	.	.	*	.	.	.	.	.	.
„ arcuatus.	Salt. Dec. G. S. 10.	Ludlow, Leintwardine.	.	.	.	.	*	.	.	.	.	.	.
„ Banksii.	Salt. Dec. G. S. 10.	Kington.	.	.	.	.	*	.	.	.	.	.	.
„ bilobus.	Salt. Sil. 178.	Lesmahago.	.	.	.	.	*	.	.	.	.	.	.
„ gigas.	Salt. Dec. G. S. 10.	Kington, Hereford.	.	.	.	.	*	.	.	.	.	.	.
„ Ludensis.	Salt. Dec. G. S. 10.	Ludlow (Paper Mill).	.	.	.	.	*	.	.	.	.	.	.
„ perornatus.	Salt. Dec. G. S. 10.	Lesmahago.	.	.	.	.	*	.	.	.	.	.	.
„ problematicus.	Ag. Dec. G. S. 10.	Ludlow, Whitcliff.	.	.	.	.	*	.	.	.	.	.	.
„ punctatus.	Salt. Dec. G. S. 10.	Leintwardine.	.	.	.	.	*	.	.	.	.	.	.
„ stylops.	Salt. Dec. G. S. 10.	Kington.	.	.	.	.	*	.	.	.	.	.	.
Remopleurides Colbii.	Port. G. Rep. 256.	Tirnaskea, Bala.	.	.	.	.	.	*	*	.	.	.	.
„ dorso-spinifer.	Port. G. Rep. 256.	Tirnaskea.	.	.	.	.	.	.	*	.	.	*	.
„ latero-spinifer.	Port. G. Rep. 256.	Bardahessia.	.	.	.	.	.	.	*	.	.	.	.
„ longicostatus.	Port. G. Rep. 257.	Desertcreat, Llandilo.	.	.	.	.	.	*	*	.	*	*	.
„ obtusus.	Salt. G. Sur. 7, 9.	Desertcreat.	.	.	.	.	.	.	*	.	.	.	.
„ platyceps.	M'C. Sil. Fos. 44.	Greenville.	.	.	.	.	.	.	.	.	.	*	.
„ radians.	Bar. S. S. Boh. 32.	Bala, Rhiwlas.	.	.	.	.	.	*	.	.	.	.	.
Sphærerochus mirus[o].	M'C. Sil. Fos. 44.	Kildare, Dudley.	.	.	.	.	*	.	.	.	*	.	.
Staurocephalus globiceps.	Port. G. Rep. 257.	Tirnaskea.	.	.	.	.	.	.	*	.	.	.	.
„ Murchisoni.	M'C. Pal. Fos. 153.	Rhiwlas, Bala.	.	.	.	.	.	*	.	.	.	.	.
Stygina latifrons[p].	Port. G. Rep. 292.	Tirnaskea.	.	.	.	.	.	.	*	*	.	*	.

[a] Calymene forcipata.
[b] Trochurus nodulosus.
[c] Asaphus Buchii.
[d] Olenus spinulosus.
[e] Portlockia apiculata.
[f] Asaphus caudatus.
[g] Dalmannia affinis.
[h] Calymene Downingiæ.
[i] Asaphus longicaudatus.
[j] Dalmannia obtusicaudata.
[k] Portlockia sublævis.
[l] Dalmannia affinis.
[m] Forbesia latifrons.
[n] Asaphus Stokesii.
[o] Sphær. calvus.
[p] Asaphus latifrons.

Name.	Authority.	Locality.	Mur. Upper.	Mur. Lower.	Phil. Upper.	Phil. Lower.	Sedg. Upper.	Sedg. Lower.	Irish, M'Coy. Tyrone.	Galway.	Kild. Dubl.	W. W. W.	Kerry.
CRUSTACEA—*continued.*													
Stygina Murchisonæ[a].	Mur. Sil. Sys. 664.	Mount Pleasant.	.	*	.	.	.	.	.	.	.	*	.
Tiresias insculptus.	M'C. Sil. Fos. 43.	Chair of Kildare.	.	.	.	.	.	.	.	.	*	.	.
Trinucleus concentricus[b].	Eaton, Sil. Sys. 659.	Welchpool, Tirnaskea.	.	*	1	3	.	**	**	.	.	**	.
" fimbriatus[c].	Mur. Sil. Sys. 660.	Builth, Welchpool.	.	*	1	.	.	.	*	.	.	*	.
" Gibbsii.	Salt. Siluria, p. 55.	St. David's.	.	.	.	.	.	*	.	.	.	.	.
" Lloydii.	Mur. Sil. Sys. 660.	Llangadock.	.	*	.	.	.	.	.	.	.	.	.
" Murchisonii.	Salt. Sil. 50.	Mytton, Dingle ?	.	*	.	.	.	*	.	.	.	.	.
" radiatus.	Mur. Sil. Sys. 660.	Welchpool.	.	*	.	1	.	.	*	.	.	**	.
" seticornis[d].	Port. G. Rep. 263.	Desertcreat.	.	.	.	.	.	*	*	.	.	**	.
" Thersites.	Salt. G. Sur. Dec. 7.	Tramore.	.	.	.	.	.	.	.	.	.	*	.
BRYOZOA.													
Cellepora favosa.	Gold. Pet. p. 216.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
Ceriopora affinis.	Gold. Pet. p. 216.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
" gracilis.	Phil. Pal. Fos. 20.	Croyde, Pilton.	.	.	.	.	*	.	.	.	.	.	.
" granulosa.	Lons. Sil. Sys. 680.	Dudley, Ledbury.	*	.	2	1	*	.	.	.	.	.	.
" similis.	Phil. Pal. Fos. 21.	Cannington Park.	.	.	.	.	*	.	.	.	.	.	.
Diastopora heterogyra[e].	M'C. Pal. Fos. 45.	Coniston.	.	.	.	.	.	*	.	.	.	.	.
" irregularis[f].	Lons. Sil. Sys. 679.	Dudley, Benthall Edge.	*	.	.	.	.	.	.	.	.	.	.
Dictyonema sociale[g].	Salt. Sil. 47.	Penmorfa, Tremadoc.	.	.	.	.	.	*	.	.	.	.	.
Dictymograpsus caduceus.	Salt. G. Jour. ix. 87.	Wexford.	.	.	.	.	.	.	.	.	.	*	.
" geminus.	His. Sil. 50.	Meadowtown.	.	.	.	.	.	*	.	.	.	.	.
" Murchisonii[h].	Beck. Sil. Sys. 694.	Llandridiod Hills.	.	*	:	4	.	*	.	.	.	.	.
" sextans.	Salt. G. Jour. v. 10.	Cairn, Ryan, Ayr.	.	.	.	.	.	*	.	.	.	.	.
Diplograpsus bullatus.	Salt. G. Jour. vii. 174.	Ayrshire.	.	.	.	.	.	*	.	.	.	.	.
" foliaceus[i].	Mur. Sil. Sys. 694.	Shelve.	.	*	.	.	*	.	*	.	.	*	.
" folium[j].	M'C. Pal. Fos. 7.	Lisbellaw, Arklow.	.	.	.	.	.	*	*	.	.	*	.
" mucronatus[k].	M'C. Pal. Fos. 7.	Cairn Ryan.	.	.	.	.	.	*	.	.	.	.	.
" nodosus.	Hark. Sil. 64.	Bran Burn.	.	.	.	.	.	*	.	.	.	.	.
" pennatus.	Hark. G. Jour. vii. 62.	Dumfriesshire.	.	.	.	.	.	*	.	.	.	.	.
" pristis[l].	Port. G. Rep. 320.	Lisbellaw, Arklow.	.	.	.	1	.	**	*	.	*	**	.
" ramosus[m].	M'C. Pal. Fos. 8.	Ireleth.	.	.	.	.	.	*	.	.	.	.	.
" rectangularis.	M'C. Pal. Fos. 8.	Moffatt, Lockerby.	.	.	.	.	.	*	.	.	.	.	.
" teretiusculus.	His. Sil. 55.	Glenkiln, Dumfries.	.	.	.	.	.	*	.	.	.	.	.
Discopora antiqua.	Lons. Sil. Sys. 679.	Dudley.	*	.	.	.	.	.	.	.	.	.	.
" favosa.	Lons. Sil. Sys. 679.	Dudley.	*	.	.	.	.	.	.	.	.	.	.
" squamata.	Lons. Sil. Sys. 679.	Dudley.	*	.	.	.	.	.	.	.	.	.	.
Escharina angularis.	Lons. Sil. Sys. 676.	Dudley.	*	.	.	.	.	.	.	.	.	.	.
Fenestella arthritica.	Phil. Pal. Fos. 25.	West Hagginton.	.	.	.	.	*	.	.	.	.	.	.
" antiqua.	Lons. Sil. Sys. 678.	Pilton, Dudley.	*	.	4	2	*	*	.	.	.	.	*
" assimilis[n].	Lons. Sil. Sys. 680.	Dudley.	*	.	.	.	.	.	*	.	*	.	.
" capillaris[o].	Port. G. Rep. 323.	Desertcreat.	.	.	.	.	.	.	*	.	.	.	.
" Londalei[p].	D'Orb. Sil. Sys. 678.	Dudley.	*	.	.	.	.	.	.	.	.	.	.
" Milleri.	Lons. Sil. Sysl. 678.	Dudley, Slieveroe.	*	.	*	.	.	*	.	.	.	*	.
" patula.	M'C. Pal. Fos. 50.	Dudley.	.	.	.	.	*	.	.	.	.	*	.
" regularis[q].	Port. G. Rep. 323.	Killey, Kildare.	.	.	.	.	.	.	*	.	*	.	.
" reticulata.	Lons. Sil. Sys. 678.	Dudley, Slieveroe.	*	.	.	.	.	.	.	.	.	*	.
" rigidula.	M'C. Pal. Fos. 50.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
" undulata[r].	Port. G. Rep. 322.	Desertcreat.	.	.	.	.	.	.	*	.	.	.	.
Glauconome bipinnata.	Phil. Pal. Fos. 21.	Croyde Bay, Pilton.	.	.	.	.	*	.	.	.	.	.	.
" disticha.	Gold. Sil. Sys. 677.	Dudley, Llansantfraid.	*	.	.	.	*	*	.	.	.	.	.
Graptolithus Conybeari.	Port. G. J. viii. 391.	Glenkiln, Dinas Bran.	.	.	.	.	.	*	.	.	.	.	.
" Flemingii.	Salt. G. J. viii. 390.	Balmae, Kirkcudbright.	.	.	.	.	.	.	.	.	.	.	.
" Griestonensis.	Nicol, G. J. vi. 63.	Grieston.	.	.	.	.	.	.	.	.	.	.	.
" latus.	M'C. Pal. Fos. 4.	Builth Bridge.	.	.	.	.	.	*	.	.	.	.	.
" lobiferus.	M'C. Pal. Fos. 4.	Lockerby, Dumfries.	.	.	.	.	.	*	.	.	.	.	.
" Nicoli.	Hark. G. J. vii. 61.	Glenkiln Burn.	.	.	.	.	.	.	.	.	.	.	.
" Nilssoni.	Bar. G. J. 761.	Little Queensberry.	.	.	.	.	.	.	.	.	.	.	.

[a] Ogygia Murchisonia.
[b] T inucleus Caractaci.
[c] Tretaspis fimbriatus.
[d] Tretaspis seticornis.
[e] Berenicea heterogyra.
[f] Berenicea irregularis.
[g] Graptopora sociale.
[h] Graptolithus Murch.
[i] Graptolithus foliaceus.
[j] Graptolithus folium.
[k] Graptolithus mucronatus.
[l] Grapt. folium.
[m] Grapt. ramosus.
[n] Gorgonia assimilis.
[o] Gorgonia capillaris.
[p] Fenestella prisca.
[q] Gorgonia regularis.
[r] Gorgonia undulata.

Name.	Authority.	Locality.	Mur. Upper.	Mur. Lower.	Phil. Upper.	Phil. Lower.	Sedg. Upper.	Sedg. Lower.	Irish, M'Coy. Tyrone.	Irish, M'Coy. Galway.	Irish, M'Coy. Kild. Dubl.	Irish, M'Coy. W. W. W.	Irish, M'Coy. Kerry.
BRYOZOA—*continued.*													
Graptolithus priodon[a].	Bronn. Sil.Sys. 694.	Ludlow.	*	.	3	3	.	.	.	.	.	.	*
„ sagittarius[b].	Linn. Sil. Sys. 694	Lisbellaw, Limehill.	.	.	.	.	.	*	*	.	.	.	.
„ Sedgwickii[c].	Port G. Rep. 318.	Limehill, Lockerby.	.	.	.	.	.	*	*	.	.	.	.
„ tenuis.	Port. G. Rep. 319.	Limehill, Lockerby.	.	.	.	.	.	*	*	.	.	.	.
Heteropora crassa.	Lons. Sil. Sys. 680.	Benthall Edge.	*	.	1	.	.	.	.	.	.	.	.
Intricaria obscura.	Port. G. Rep. 326.	Desertcreat.	.	.	.	.	.	.	*	.	.	.	.
Nidulitis favus.	Salt. Sil. 203.	Ferriter's Cove.	.	.	.	.	.	*	.	.	*	.	*
Phyllopora Hysingeri[d].	M'C. Pal. Fos. 48.	Coniston.	.	.	.	.	.	**	.	.	.	.	.
Polypora crassa[e].	Lons. Sil. Sys. 677.	Dudley.	*	.	.	.	.	.	.	.	.	.	.
Protovirgularia dichotoma.	M'C. Pal. Fos. 10.	Lockerby, Dumfries.	.	.	.	.	.	*	.	.	.	.	.
Ptylodictya acuta[f].	M'C. Pal. Fos. 45.	Llansantfraid.	.	.	.	.	.	*	*	.	*	.	.
„ costellata[g].	M'C. Pal. Fos. 46.	Girvan, Ayr.	.	.	.	.	.	*	.	.	.	.	.
„ dichotoma.	Port. G. Rep. 339.	Desertcreat.	.	.	1	3	.	.	*	*	*	.	.
„ explanata.	M'C. Pal. Fos. 46.	Coniston.	.	.	.	.	.	**	.	.	.	.	.
„ fucoides.	M'C. Pal. Fos. 47.	Gelligrin, Bala.	.	.	.	.	.	*	.	.	.	.	.
„ lanceolata[h].	Lons. Sil. Sys. 676.	Malverns.	*	.	4	1	*	*	.	.	*	.	.
„ scalpellum.	Lons. Sil. Sys. 679.	Dudley.	*	.	.	.	.	.	.	.	.	.	.
Rastrites Barrandii.	Hark. G. J. xi. 475.	Glenkiln, Burn.	.	.	.	.	.	*	.	.	.	.	.
„ peregrinus.	Barr. Sil. 64.	Bogmine.	.	.	.	.	.	*	.	.	.	.	.
Retepora infundibulum.	Lons. Sil. Sys. 679.	Dudley.	*	.	.	1	.	.	.	.	.	.	.
Retiolites Geinitzianus.	Barr.Grapt.Boh.69.	?	.	.	.	.	.	*	.	.	.	.	.
„ venosus.	Hall, Pal.N.Y. ii.40.	Heathmont.	.	.	.	.	.	*	.	.	.	.	.
BRACHIOPODA.													
Athyris circe.	Barr. Bull. S.G. 326.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
„ obovata.	Sow. Sil. Sys. 618.	Mathon Lodge.	*	.	2	1	.	.	.	.	.	.	.
„ tumida[i].	Sow. Sil. Sys. 623.	Walsall, Woolhope.	*	.	5	1	*	.	.	.	.	.	*
Atrypa aspera[j].	Sow. Sil. Sys. 623.	Palmer's Cairn, Benthall Edge.	*	.	.	.	*	**	.	*	.	.	**
„ crassa[k].	Sow. Sil. Sys. 636.	Cefn Rhyddau.	.	*	.	1	.	***	.	.	.	.	.
„ hemispherica.	Sow. Sil. Sys. 637.	Ankerdine Hill.	.	*	3	2	.	**	.	***	.	.	*
„ Lewisii.	Dav. Bull. S. G.	Walsall.	.	.	.	.	*	*	.	.	.	.	.
„ marginalis[l].	Sow. Sil. Sys. 624.	Wenlock, Kildare.	*	.	4	1	*	**	.	.	*	.	*
„ orbicularis.	Sow. Sil. Sys. 637.	Malvern, May Hill.	*	.	2	2	.	.	.	**	.	.	.
„ reticularis[m].	Sow. Sil. Sys. 614.	Ludlow, Aymestry.	*	.	6	4	**	**	.	*	.	.	***
Chonetes lata[n].	Sow. Sil. Sys. 610.	Ludlow, Tyrone.	*	.	.	3	**	*	*	*	.	*	*
„ plicata[o].	Sow. Sil. Sys. 610.	Goleugoed, Bala.	.	*	.	.	.	.	.	.	.	*	.
„ sarcinulata.	Sow. G. Tr.	Dingle (Salter).	.	.	6	2	.	.	.	.	.	.	*
Crania craniolaris.	M'C. Pal. Fos. 255.	Builth Bridge.	.	.	.	.	.	*	.	.	.	.	.
„ divaricata.	M'C. Pal. Fos. 187.	Bala, Builth.	.	.	.	.	.	*	.	.	.	.	.
„ Sedgwickia.	Dav. Bull. S. G.	Walsall.	.	.	.	.	*	.	.	.	.	.	.
Discina Forbesii.	Dav. Bull. S. G.	Walsall.	.	.	.	.	*	.	.	.	.	.	.
„ implicata[p].	Sow. Sil. Sys. 625.	Abberley, Llandilo.	*	.	3	.	.	*	.	.	.	.	.
„ lævigata.	Port. G. Rep. 345.	Tirnaskea, Llandilo.	.	.	3	2	.	*	*	.	.	.	.
„ Morrisii.	Dav. Bul. S. G.	Leintwardine.	.	.	.	.	*	.	.	.	.	.	.
„ oblongata[q].	Port. G. Rep. 445.	Tirnaskea, Horderly.	.	.	.	.	.	*	*	.	.	.	.
„ perrugata[r].	M'C. Sil. Fos. 24.	Kilbride.	.	.	.	.	.	.	.	*	.	.	*
„ punctata.	Sow. Sil. Sys. 636.	Chatwall.	*	.	.	1	.	.	.	.	.	.	.
„ rugata[s].	Sow. Sil. Sys. 610.	Ludlow, Pain's Castle.	*	.	6	1	.	.	.	.	.	.	.
„ striata[t].	Sow. Sil. Sys. 610.	Delbury, Tyrone.	*	.	.	1	*	.	*	.	.	.	.
„ subrotunda.	Port. G. Rep. 445.	Desertcreat.	.	.	.	.	.	.	*	.	.	.	.
„ Verneuillii.	Dav. Bul. S. G.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
Leptæna calcarata[u].	M'C. Sil. Fos. 28.	Greenville, Slieveroe.	.	.	.	.	.	.	.	.	.	*	.
„ convoluta.	Phil. Pal. Fos. 57.	Croyde Bay.	.	.	.	.	*	.	.	.	.	.	.
„ lævigata[v].	Sow. Sil. Sys. 629.	Burrington.	*	.	*	.	.	.	.	.	.	.	.
„ lævissima.	M'C. Sil. Fos. 27.	Ferriter's Cove.	.	.	.	.	.	.	.	.	.	.	*
„ minima.	Sow. Sil. Sys. 629.	Burrington.	*	.	*	.	*	*	.	.	.	.	.

[a] Grap. Ludensis.
[b] Grapt. laxus.
[c] Grap. distans.
[d] Retepora Hisingeri.
[e] Hornera crassa.
[f] Stictopora acuta.
[g] Stictopora costellata.
[h] Flustra lanceolata.
[i] Atrypa tumida.
[j] Atr. reticularis.
[k] Spirifer per-crassa.
[l] Terebratula imbricata.
[m] Atr. affinis.
[n] Leptæna lata.
[o] Leptæna plicata.
[p] Patella implicata.
[q] Orbicula oblongata.
[r] Orbicula perrugata.
[s] Orbicula rugata.
[t] Orbicula striata.
[u] Orthis calcarata.
[v] Lept. lepisma.

Name.	Authority.	Locality.	Mur. Upper.	Mur. Lower.	Phil. Upper.	Phil. Lower.	Sedg. Upper.	Sedg. Lower.	Irish, M'Coy. Tyrone.	Irish, M'Coy. Galway.	Irish, M'Coy. Kild. Dubl.	Irish, M'Coy. W. W. W.	Irish, M'Coy. Kerry.
BRACHIOPODA—*cont.*													
Leptæna oblonga	Pand. G. Sur. ii.285.	Sholes Hook.	.	.	.	1	.	.	.	.	.	.	.
" Orbingyi.	Dav. Bul. S. G.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
" quinquecostata[a].	M'C. Pal. Fos. 236.	Kildare, Goleugoed.	.	.	.	.	.	**	.	*	*	.	.
" sericea.	Sow. Sil. Sys. 636.	Malverns, Bala.	*	*	2	2	.	***	**	*	*	**	**
" sublævis[b],	M'C. Sil. Fos. 35.	Kildare.	.	.	.	.	.	.	.	.	*	.	.
" tenuicincta.	M'C. Pal. Fos. 239.	Cefn Grugos, Kildare.	.	.	.	.	.	*	.	.	*	.	.
" transversalis[c].	Sow. Sil. Sys. 629.	Dudley, Bala.	*	*	3	2	*	*	*	*	*	.	.
" ungula.	M'C. Pal. Fos. 249.	Selattyn, Bala.	.	.	.	.	.	**	.	.	.	.	.
Lingula attenuata.	Sow. Sil. Sys. 641.	Llandilo, Kilbride.	.	*	2	1	.	*	*	*	.	.	.
" brevis.	Port. G. Rep. 443.	Tirnaskea.	.	.	.	.	.	.	*	.	.	.	.
" cornea[d].	Sow. Sil. Sys. 603.	Ludlow, Benson Knot.	*	.	2	.	*	.	.	.	.	.	*
" crumena.	Phil. G. Sur. ii. 275.	Howler's Heath.	.	.	1	.	.	.	.	.	.	.	.
" curta.	M'C. Pal. Fos. 251.	Wellfield, Builth.	.	.	.	.	.	*	.	.	.	.	.
" Davisi.	M'C. Pal. Fos. 252.	Penmorfa, Tremadoc.	.	.	.	.	.	*	.	.	.	.	.
" granulata.	Phil. G. Sur. ii. 275.	Llandilo.	.	.	.	2	.	*	.	.	.	.	.
" lata.	Sow. Sil. Sys. 618.	Ludlow, Tyrone.	*	.	.	.	*	.	*	.	.	.	.
" Lewisii.	Sow. Sil. Sys. 615.	Aymestry, Ardaun.	*	.	4	2	*	*	.	*	.	.	.
" longissima.	M'C. Pal. Fos. 253.	Mynydd Fron Frys.	.	.	.	.	.	*	.	.	.	.	.
" obtusa.	M'C. Pal. Fos. 251.	Llandilo (M'Coy).	.	.	.	.	.	*	.	.	.	.	.
" ovata.	M'C. Sil. Fos. 24.	Kildare, Bala.	.	.	.	.	.	*	.	.	*	*	.
" parallela.	Phil. G. Sur. ii. 276.	Malvern.	.	.	1	.	.	.	.	.	.	.	.
" plumbea.	Salt. Sil. 50.	Ritton Castle ?	.	.	.	.	.	*	.	.	.	.	.
" Ramsayi.	Salt. Sil. 55.	Lampeter, Felfry.	.	.	.	.	.	*	.	.	.	.	.
" striata.	Sow. Sil. Sys. 619.	Aymestry.	*	.	.	.	.	.	.	.	.	.	.
" tenuigranulata.	M'C. Pal. Fos. 254.	Meifod.	.	.	.	.	.	*	.	.	.	.	.
Obolus Davidsoni.	Salt.Dav.Brach.136	Dudley.	.	.	.	.	*	.	.	.	.	.	.
" transversus.	Salt.Dav.Brach.136	Walsall.	.	.	.	.	*	.	.	.	.	.	.
Orthis Actoniæ.	Sow. Sil. Sys. 639.	Bala, Killey.	.	*	.	2	.	***	*	.	*	***	*
" æquivalvis.	Dav. Bul. S. G.	Walsall.	.	.	.	.	*	.	.	.	.	.	.
" alata.	Sow. Sil. Sys. 638.	Coniston.	.	*	.	1	.	.	.	.	.	.	.
" alternata[e].	Sow. Sil. Sys. 638.	Soudley, Tyrone.	.	*	2	2	.	***	*	*	*	*	.
" biforata[f].	M'C. Pal. Fos. 192.	Dudley, Bala.	.	.	.	2	*	**	.	.	*	*	.
" biloba[g].	Sow. Sil. Sys. 640.	Horderly, Malvern.	*	*	3	2	.	*	*	.	.	.	.
" Bouchardii.	Dav. Bul. S. G.	Benthall Edge.	.	.	.	.	*	.	.	.	.	.	.
" calcar.	Phil. Pal. Fos. 138.	Pilton.	.	.	.	.	*	.	.	.	.	.	.
" calligramma[h].	Sow. Sil. Sys. 639.	Horderly, Tirnaskea.	.	*	3	3	.	**	*	*	*	***	*
" compressa.	Sow. Sil. Sys. 629.	Hope Quarry, Linton.	.	*	.	2	*	.	*	*	.	*	*
" confinia.	Salt. G. Sur. v. 15.	Girvan, Llandilo.	.	.	.	.	.	*	.	.	.	.	.
" costata.	Sow. Sil. Sys. 639.	Cefn, Killey.	.	*	1	2	.	.	*	.	.	.	.
" crispa.	M'C. Sil. Fos. 29.	Bala, Waterford.	.	.	.	.	.	*	*	.	.	*	*
" Davidsoni.	Vern. Sil. 251.	Malverns.	.	.	.	.	*	.	.	.	.	.	.
" elegantula[i].	Sow. Sil. Sys. 611.	Dudley, Tirnaskea.	*	.	5	5	.	***	*	***	*	***	*
" fallax.	Salt. Sil. Fos. 72.	Killey	.	.	.	.	.	.	*	.	.	.	.
" granulosa.	Phil. Pal. Fos. 65.	Woodabay.	.	.	.	.	*	.	.	.	.	.	.
" flabellulum.	Sow. Sil. Sys. 639.	Bala, Caradoc.	.	*	1	2	.	***	.	*	.	.	.
" Hirnantensis.	M'C. Pal. Fos. 219.	Hirnant, Bala.	.	.	.	.	.	**	.	.	.	.	.
" hybrida.	Sow. Sil. Sys. 630	Walsall, Tyrone.	*	.	5	.	*	.	*	.	.	.	*
" insularis[j].	M'C. Sil. Fos. 30.	Kildare, Portrane.	.	.	.	1	.	*	.	.	*	.	.
" intercostata.	Port. G. Rep. 454.	Killey.	.	.	.	.	.	.	*	.	.	.	.
" interlineata.	Phil. Pal. Fos. 63.	Woodabay, Pilton.	.	.	.	.	*	.	.	.	.	.	*
" interplicata.	M'C. Sil. Fos. 31.	Kildare.	.	.	.	.	.	.	.	.	*	.	.
" lata[k].	Sow. Sil. Sys. 640.	Gortlwyn, Horeb Chapel.	*	.	.	3	.	.	.	.	.	*	*
" Lewisii.	Dav.Bul.S.G.v. 323.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
" longisulcata.	Phil. Pal. Fos. 62.	Linton, Woodabay.	.	.	.	.	*	.	.	.	.	.	.
" lunata[l].	Sow. Sil. Sys. 611.	Ludlow, Horeb Chapel.	*	.	5	2	**	*	*	.	.	*	*
" parva[m].	M'C. Sil. Fos. 32.	Killey, Bala.	.	.	.	.	.	***	*	.	.	*	.
" plicata[n].	Sow. Sil. Sys. 638.	Bala, Meifod.	.	.	.	.	.	***	.	.	.	.	.
" porcata[o].	M'C. Pal. Fos. 223.	Portrane, Bala.	.	.	.	.	.	**	.	.	*	.	.
" productoides.	M'C. Sil. Fos. 32.	Knockmahon.	.	.	.	.	.	.	.	.	.	*	.
" radians.	Sow. Sil. Sys. 639.	Golengoed.	.	*	.	*	.	.	*	.	.	*	.
" remota.	Salt. Sil. 53.	Bala, Ash Gill.	.	.	.	.	.	*	.	.	.	.	.

[a] Orthis quinquecostata.
[b] Orthis sublævis.
[c] Lept. Fletcheri.
[d] Ling. minima.
[e] Orthis pecten.
[f] Terebratulites biforatus.
[g] Spirifer sinuatus.
[h] Spirifer plicatus.
[i] Orthis canalis.
[j] Orthis gala.
[k] Orthis protensa.
[l] Orth. orbicularis.
[m] Orth. parva.
[n] Orthis virgata.
[o] Orthis inflata.

Name.	Authority.	Locality.	Mur. Upper.	Mur. Lower.	Phil. Upper.	Phil. Lower.	Sedg. Upper.	Sedg. Lower.	Irish, M'Coy. Tyrone.	Galway.	Kild. Dubl.	W. W. W.	Kerry.
BRACHIOPODA—*cont.*													
Orthis retrorsistria.	M'C. Pal. Fos. 224.	Bala, Ash Gill.	.	*	.	.	.	**	.	.	.	.	.
,, reversa.	Salt. Sil. Fos. 72.	Galway, Mulock.	.	.	*	*	.	*	.	*	.	.	.
,, rustica.	Sow. Sil. Sys. 624.	Wenlock.	*	.	*	.	*	*	.	.	.	.	**
,, sagittifera.	M'C. Pal. Fos. 227.	Aber, Hirnant.	.	.	.	.	.	*	.	.	.	.	.
,, sarmentosa.	M'C. Sil. Fos. 34.	Slieve Roe, Llyn Ogwen.	.	.	.	.	.	*	.	.	.	*	.
,, semicircularis.	Sow. Sil. Sys. 639.	Corndon, Pilton.	.	*	*	*	*	.	.	.	.	*	*
,, simplex.	M'C. Sil. Fos. 34.	Knockmahon.	.	.	.	.	.	.	.	.	*	*	.
,, sordida.	Phil. Pal. Fos. 62.	Linton.	.	.	.	.	*	*	.	.	.	.	.
,, spiriferoides.	M'C. Pal. Fos. 246.	Bala, Welch Pool.	.	.	.	.	.	*	.	.	.	.	.
,, striatula.	Salt. Sil. 55.	Llandilo	.	.	.	.	.	**	.	.	.	.	.
,, testudinaria.	Sow. Sil. Sys. 641.	Gaerfawr, Tirnaskea.	.	*	1	3	.	**	*	.	*	**	.
,, triangularis.	Sow. Sil. Sys. 640.	Marrington, Dingle.	.	*	.	.	.	.	.	.	.	*	.
,, turgida.	M'C. Pal. Fos. 229.	Aber, Hirnant.	.	.	.	.	.	**	.	.	.	.	.
,, undata.	M'C. Sil. Fos. 36.	Uggool.	.	.	.	.	.	.	.	*	*	.	.
,, unguis.	Sow. Sil. Sys. 640.	Horderly.	.	*	.	.	.	.	.	.	.	.	.
,, vespertilio[a].	Sow. Sil. Sys. 640.	Corton, Killey.	.	*	2	2	.	***	*	.	*	.	*
Orthisina ascendens.	M'C. Pal. Fos. 231	Cefn Coedog, Corwen.	.	.	.	.	.	*	.	.	.	.	.
,, Scotica.	M'C. Pal. Fos. 232.	Craig Head, Ayr.	.	.	.	.	.	*	.	.	.	.	.
Pentamerus galeatus[b].	Sow. Sil. Sys. 618.	Ludlow, Llandilo.	*	.	5	2	*	*	.	.	.	.	*
,, globosus[c].	Sow. Sil. Sys. 637.	Castell Craig, Coolin.	.	*	1	2	.	*	.	*	*	.	.
,, Knightii.	Sow. Sil. Sys. 615.	Aymestry, The Hollies.	*	.	2	.	*	*	.	.	.	.	*
,, lævis.	Sow. Sil. Sys. 641.	Noeth Grug, Bala.	.	*	3	3	.	*	.	.	.	.	.
,, lens[d].	Sow. Sil. Sys. 637.	May Hill, Coniston.	.	*	2	2	.	**	.	*	.	.	.
,, linguiferus.	Sow. Sil. Sys. 629.	Woolhope.	*	*	3	.	.	.	.	.	.	.	.
,, liratus.	Sow. Sil. Sys. 638.	Marloes Bay.	.	*	.	1	.	.	.	.	.	.	.
,, oblongus.	Sow. Sil. Sys. 641.	The Hollies, Horderly.	.	*	2	1	.	**	.	*	.	.	.
,, undatus[e].	Sow. Sil. Sys. 637.	Robeston, Wathen.	.	*	2	2	.	**	.	.	*	.	.
Porambonites Capewellii.	Dav. Sil. 250.	Walsall.	.	.	.	.	*	.	.	.	.	.	.
,, crassa.	Sow. Sil. Sys. 636.	Coniston.	.	*	.	.	.	.	.	.	.	.	.
,, intercedens.	Pand. Beitr. t. 11.	Wrae Quarry, Scotland.	.	.	.	.	.	*	.	.	.	.	.
Retzia Barrandei.	Dav. Bull. S. G. v. 332.	Walsall ?	.	.	.	.	*	.	.	.	.	.	.
,, Bayleyi.	Dav. Sil. 250.	Benthall Edge ?	.	.	.	.	*	.	.	.	.	.	.
,, Bouchardii.	Dav. Sil. 250.	Walsall ?	.	.	.	.	*	.	.	.	.	.	.
,, cuneata[f].	Sow. Sil. Sys. 625.	Wenlock, Tirnaskea.	*	.	3	.	*	.	*	*	.	.	.
,, Lewisii.	Dav. Bull. S. G. v. 230.	Walsall ?	.	.	.	.	*	.	.	.	.	.	.
,, Salteri.	Dav. Sil. 250.	Dudley.	.	.	.	.	*	.	.	.	.	.	.
Rhynchonella angustifrons[g].	M'C. Pal. Fos. 199	Craig Head, Ayr.	.	.	.	.	.	*	.	.	.	.	.
,, borealis[h].	Sow. Sil. Sys. 611.	Dudley, Tirnaskea.	*	.	5	3	*	.	*	.	.	.	*
,, brevirostrum.	Sow. Sil. Sys. 631.	Croft, Woolhope.	*	.	2	.	.	.	.	.	.	.	.
,, compressa[i].	Sow. Sil. Sys. 629.	Woodside, Presteign.	*	.	.	.	.	.	.	.	.	.	.
,, crebricosta.	Sow. Sil. Sys. 631.	Tynewidd.	*	.	.	.	.	.	.	.	.	.	.
,, crispata[k].	Sow. Sil. Sys. 624.	Nashscar, Tyrone.	*	.	1	1	*	.	*	.	.	.	.
,, Davidsonii[l].	M'C. Pal. Fos. 200.	Burton, Brockton.	.	.	.	.	*	.	.	.	.	.	.
,, decemplicata[m].	Sow. Sil. Sys. 641.	Eastnor Park.	.	*	2	2	.	*	.	.	.	.	.
,, deflexa.	Sow. Sil. Sys. 625.	Wenlock Edge.	*	.	4	1	.	.	.	.	.	.	.
,, depressa[n].	Sow. Sil. Sys. 629.	Malverns, Bala.	*	*	1	1	.	*	.	.	.	.	.
,, didyma[o].	Dalm. Sil. xxii. 15.	Ledbury.	*	.	3	2	*	.	.	.	.	.	*
,, furcata.	Sow. Sil. Sys. 640.	Corndon Hills.	.	*	2	1	.	.	.	.	.	.	*
,, Grayii.	Dav. Sil. 250.	Walsall.	.	.	.	.	*	.	.	.	.	.	.
,, interplicata.	Sow. Sil. Sys. 631.	Woolhope.	*	.	1	.	.	.	.	.	.	.	.
,, laticosta.	Phil. Pal. Fos. 85.	Baggy Point.	.	.	.	.	*	.	.	.	.	.	.
,, Lewisii.	Dav. Bul. S. G.	Walsall, Mathyrafal	.	.	.	.	*	*	.	.	.	.	.
,, nasuta.	M'C. Pal. Fos. 203.	Craig Head, Girvan.	.	.	.	.	.	*	.	.	.	.	.
,, navicula[p].	Sow. Sil. Sys. 611.	Ludlow, Welchpool.	*	.	4	2	*	*	*	*	*	.	**
,, neglecta.	Sow. Sil. Sys. 641.	Mandinam.	.	*	.	.	.	.	.	.	.	.	.
,, nucula[q].	Sow. Sil. Sys. 611.	Dudley, Horeb Chapel.	*	.	4	1	**	*	*	*	.	.	**
,, pentagona.	Sow. Sil. Sys. 612.	Delbury, Clungunford.	*	.	.	.	.	*	.	.	.	.	.
,, pleurodon.	Phil. Geol. J.	Croyde Bay, Pilton.	.	.	.	.	*	.	.	.	.	.	.
,, pusilla.	Sow. Sil. Sys. 641.	Cefn Rhyddan.	.	*	.	.	.	.	.	.	.	.	.

[a] O. bilobata.
[b] Atrypa galeata.
[c] Atrypa globosa.
[d] Atrypa lena.
[e] Atrypa undata.
[f] Terebratula cuneata.
[g] Hemithyrus ang.
[h] Ter. lacunosa.
[i] Atrypa compr.
[k] Terebratula crisp.
[l] Terebratula sphærica.
[m] Ter. bidentata.
[n] Atrypa depressa.
[o] Terebratula did.
[p] Terebratula navicula.
[q] Tereb. pulchra.

Name.	Authority.	Locality.	Mur. Upper.	Mur. Lower.	Phil. Upper	Phil. Lower.	Sedg. Upper.	Sedg. Lower.	Irish, M'Coy. Tyrone.	Galway.	Kild. Dubl.	W. W. W.	Kerry.
BRACHIOPODA—*cont.*													
Rhynchonella rotunda[a].	Sow. Sil. Sys. 629.	Wenlock Edge, Alt Goch.	*	.	1	.	.	1	.	*	.	.	.
" serrata.	M'C. Sil. Fos. 41.	Maume.	.	.	.	.	.	.	.	***	.	.	.
" sexcostata[b].	M'C. Sil. Fos. 41.	Lettershanbally.	.	.	.	.	.	.	.	*	.	.	.
" sphærica.	Sow. Sil. Sys. 631.	Tame Bridge.	*	.	2	.	.	.	.	.	.	.	.
" sphæroidalis.	M'C. Pal. Fos. 206.	Dudley, The Hollies.	.	.	.	.	*	.	.	.	.	.	.
" Stricklandi[c].	Sow. Sil. Sys. 631.	Longhope, Wenlock.	*	.	4	.	*	.	.	.	.	.	.
" subundata.	M'C. Pal. Fos. 207.	Meifod.	.	.	.	.	.	*	.	.	.	.	.
" tripartita.	Sow. Sil. Sys. 641.	Goleugoed.	.	*	.	1	.	.	.	.	.	.	.
" upsilon.	M'C. Pal. Fos. 207.	Pwlheli.	.	.	.	.	.	*	.	.	.	.	.
" Wilsoni[d].	Sow. Sil. Sys. 615.	Aymestry, Kilbride.	*	.	5	2	*	*	.	*	.	.	*
Siphonotrela Anglica.	Mor. M'C. P. F. 188.	Dudley, Coniston.	.	.	.	.	*	*	.	.	.	.	.
" micula.	M'C. Pal. Fos. 188.	Builth, Pentre.	.	.	.	.	.	*	.	.	.	.	.
Spirifer aperturata.	Phil. Pal. Fos. 77.	Linton.	.	.	.	.	*	.	.	.	.	.	.
" calcarata.	Phil. Pal. Fos. 73.	Linton, Val. of Rocks.	.	.	.	.	*	.	.	.	.	.	.
" crispa[e].	Sow. Sil. Sys. 624.	Dudley, Llandilo.	*	.	***	*	.	*	.	.	.	.	*
" disjuncta.	Phil. Pal. Fos. 74.	Baggy Point.	.	.	.	.	*	.	.	.	.	.	.
" elevatus[f].	Sow. Sil. Sys. 624.	Dudley, Felindre.	*	.	***	**	.	.	.	.	.	.	*
" lævicosta[g].	Phil. Pal. Fos. 76.	Linton, Val. of Rocks.	.	.	.	.	*	.	.	.	.	.	.
" ovata.	M'C. Sil. Fos. 37.	Uggool, Ardaun.	.	.	.	.	.	.	.	*	.	.	.
" pisum.	Sow. Sil. Sys. 630.	Hay Head, Wenlock.	*	.	*	.	.	.	.	.	.	.	.
" plicatellus[h].	Sow. Sil. Sys. 603.	Dudley, Tyrone.	*	.	***	**	.	.	*	*	*	*	**
" rudis.	Phil. Pal. Fos. 78.	Baggy Point.	.	.	.	.	*	.	.	.	.	.	.
" speciosa.	Phil. Pal. Fos. 77.	Ogwell, Ferriters.	.	.	.	.	*	.	.	.	.	.	*
" trapezoidalis[i].	Sow. Sil. Sys. 610.	Woolhope, Llandilo.	*	.	**	*	.	*	.	.	.	.	*
Strophalosia caperata.	Phil. Pal. Fos. 58.	Croyde Bay, Pilton.	.	.	.	.	*	.	.	.	.	.	.
Strophomena alternata[j].	Sow. Sil. Sys. 638.	Girvan, Ardaun.	.	*	.	.	.	*	.	*	*	*	.
" analoga.	Phil. Pal. Fos. 56.	Croyde Bay.	.	.	.	.	*	.	.	.	.	.	.
" anomala.	Sow. Sil. Sys. 638.	Horderly.	.	*	.	.	.	.	.	.	.	.	.
" antiquata[k].	Sow. Sil. Sys. 630.	Woolhope, Bala.	*	.	*	.	.	*	.	.	*	.	.
" applanata.	Salt. Sil. Fos. Add.	Usk, Coolin.	.	.	*	.	.	*	.	*	.	.	*
" complanata[l].	Sow. Sil. Sys. 636.	Acton, Burnell.	.	*	*	.	.	.	.	.	*	*	.
" compressa[m].	Sow. Sil. Sys. 638.	Shelve, Marloes Bay.	.	*	.	.	.	*	*	*	*	*	*
" concentrica[n].	Port. G. Rep. 452.	Tirnaskea	.	.	.	.	.	.	*	.	*	*	.
" corrugata[o].	Port. G. Rep. 450.	Llandilo, Kildare.	.	.	*	*	.	*	*	*	*	.	.
" deltoidea[p].	M'C. Pal. Fos. 234.	Kildare, Coniston.	.	.	.	.	.	*	.	.	*	.	.
" depressa[q].	Sow. Sil. Sys. 623.	Mocktree.	*	.	6	2	*	**	*	***	*	*	**
" euglypha[r].	Sow. Sil. Sys. 622.	Mocktree, Wenlock.	*	.	5	2	.	*	*	.	*	.	*
" expansa.	Sow. Sil. Sys. 638.	Moel y Garth.	.	*	4	2	.	.	*	.	.	.	.
" filosa[s].	Sow. Sil. Sys. 630.	Burrington, Doonquin.	*	.	4	4	*	*	.	.	.	*	*
" funiculata[t].	M'C. Sil. Fos. 50.	Ballyaglish, Dudley.	.	.	3	1	*	.	.	.	.	.	*
" grandis[u].	Sow. Sil. Sys. 638.	Horderly, Tyrone.	.	*	.	1	.	.	*	.	.	.	.
" imbrex[v].	Pand. Sil. 251.	Walsall.	.	.	.	.	*	.	.	*	*	.	.
" Ouralensis[w].	M'C. Pal. Fos. 236.	Presteign.	.	.	.	.	*	.	.	.	.	.	.
" pecten[x].	Sow. Sil. Sys. 638.	Horderly, Bala.	.	*	1	2	*	*	*	.	.	.	*
" plicotis[y].	M'C. Sil. Fos. 25.	Kildare.	.	.	.	.	.	.	.	.	*	.	.
" rugifera[z].	Port. G. Rep. 453.	Tirnaskea.	.	.	.	.	.	.	*	.	.	*	.
" simulans.	M'C. Pal. Fos. 246.	Goldengrove.	.	.	.	.	.	*	.	.	.	*	*
" tenuistriata[aa].	Sow. Sil. Sys. 636.	May Hill, Grug.	.	.	3	1	.	*	*	*	*	.	.
" undata[bb].	M'C. Pal. Fos. 234.	Bala, Uggool.	.	.	.	.	.	**	.	*	.	.	.
Strigocephalus Burtini.	De. Fr. P. P. F. 79.	CombeMartin,Hagginton	.	.	.	.	*	.	.	.	.	.	.
Terebratula læviuscula.	Sow. Sil. Sys.	Tynewidd.	*	.	.	.	.	.	.	.	.	.	.
Trematis punctata.	Sow. Sil. Sys. 636.	Chatwall, Caradoc.	.	*	.	.	.	.	.	.	.	.	.
MONOMYARIA.													
Ambonychia acuticosta.	M'C. Pal. Fos. 264.	Dinas Bran.	.	.	.	.	*	.	.	.	.	.	.

[a] Atrypa rotunda.
[b] Atrypa sex.
[c] Ter. Strickl.
[d] Terebratula Wilsoni.
[e] Anomia crispa.
[f] Spir. ptychodes.
[g] Spir. ostiolata.
[h] Spir. interlineatus.
[i] Cyrtia trap.
[j] Str. bipartita.
[k] Orthis ant.
[l] Lept. compl.
[m] Orthis com.
[n] Orthis con.
[o] Orthis corr.
[p] Leptagonia semiovalis.
[q] Lept. depressa.
[r] Leptæna eugl.
[s] Orthis filosa.
[t] Orth. fun.
[u] O. cancellata.
[v] Orthis imbr.
[w] Lept. Oural.
[x] Orthis pect.
[y] Leptagonia plic.
[z] Orthis rug.
[aa] Lept. ten.
[bb] Orthis undata.

Name.	Authority.	Locality.	Mur. Upper.	Mur. Lower.	Phil. Upper.	Phil. Lower.	Sedg. Upper.	Sedg. Lower.	Irish, M'Coy. Tyrone.	Irish, M'Coy. Galway.	Irish, M'Coy. Kild. Dubl.	Irish, M'Coy. W. W. W.	Irish, M'Coy. Kerry.
MONOMYARIA—*cont.*													
Ambonychia gryphus[a].	Port. G. Rep. 455.	Tirnaskea.	.	.	.	.	.	.	*	.	.	.	.
" transversa[b].	Port. G. Rep. 455.	Bardahessia.	.	.	.	.	.	.	*	.	.	.	.
" trigona[c].	Port. G. Rep. 422.	Lisbellaw, Uggool.	.	.	.	.	.	.	*	*	.	.	.
" Triton.	Salt. G. Sur. ii. 270.	Bird's Hill.	.	.	.	1	.	*	.	.	.	.	.
" undata.	Port. G. Rep. 442.	Tirnaskea.	.	.	.	.	.	.	*	.	.	.	.
Avicula ampliata.	Phil. G. Sur. ii. 270.	Llangadoc.	.	.	1	1	.	.	.	.	.	.	.
" antiqua.	Gold. Pet. 283.	Westmoreland.	.	.	.	.	*	.	.	.	.	.	.
" bullata.	M'C. Sil. Fos. 23.	Maume.	.	.	.	.	.	.	.	*	.	.	.
" cancellata.	Phil. Pal. Fos. 49.	Baggy Point, Croyde.	.	.	.	.	*	.	.	.	.	.	.
" Damnoniensis.	Phil. Pal. Fos. 51.	Marwood.	.	.	.	.	*	.	.	.	.	.	.
" Danbyi.	M'C. Pal. Fos. 258.	Benson Knot.	.	.	.	.	*	.	.	.	.	.	.
" panopaeaformis[d].	M'C. Sil. Fos. 22.	Tirnaskea, Doonquin.	.	.	.	.	.	.	*	.	.	.	*
" rudis.	Phil. Pal. Fos. 50.	Pilton, Boocaun.	.	.	.	.	*	.	.	*	.	.	.
Pecten transversus.	Phil. Pal. Fos. 46.	Pilton, Croyde.	.	.	.	.	*	.	.	.	.	.	.
Inoceramus contortus.	Port. G. Rep. 422.	Tirnaskea.	.	.	.	.	.	.	*	.	.	.	.
" priscus.	Port. G. Rep. 423.	Tirnaskea.	.	.	.	.	.	.	*	.	.	.	.
Posidonomya venusta.	Port. G. Rep. 424.	Limehill.	.	.	.	.	.	.	*	.	.	.	.
Pterinea asperula.	M'C. Pal. Fos. 259.	Builth Bridge.	.	.	.	.	.	*	.	.	.	.	.
" Boydi.	M'C. Pal. Fos. 259.	Brigsteer, Kendal.	.	.	.	.	*	.	.	.	.	.	.
" demissa[e].	M'C. Pal. Fos. 260.	Benson Knot, Llandilo.	.	.	.	.	*	*	.	.	.	.	.
" fimbriata.	M'C. Sil. Fos. 21.	Ferriter's Cove.	.	.	.	.	.	.	.	.	.	.	*
" hians.	M'C. Pal. Fos. 260.	Aymestry.	.	.	.	.	*	.	.	.	.	.	.
" lineata[f].	Sow. Sil. Sys. 610.	Ludlow, Ferriters.	*	.	4	2	*	*	.	*	.	.	*
" lineatula.	Sow. Sil. Sys. 610.	Ludlow.	*	.	.	.	.	.	.	*	.	.	*
" megaloba.	M'C. Pal. Fos. 261.	Storm Hill, Llandilo.	.	.	.	.	.	*	.	.	.	.	.
" orbicularis.	Sow. Sil. Sys. 635.	Horderly, Doonquin.	.	*	1	2	.	*	.	.	.	.	*
" planulata.	Con. G. Sur. ii. 368.	Walsall.	.	.	5	1	*	.	.	.	.	.	*
" pleuroptera[g].	M'C. Pal. Fos. 261.	Wrexham, Benson Knot.	.	.	.	.	*	*	.	.	.	.	*
" rectangularis.	Sow. Sil. Sys. 603.	Horeb Chapel.	*	.	4	1	.	.	.	.	.	.	.
" retroflexa[h].	Sow. Sil. Sys. 609.	Usk, Boocaun.	*	.	5	3	*	*	.	*	.	.	*
" reticulata[i].	Phil. G. Sur. ii. 271.	Aymestry, Doonquin.	.	.	4	2	*	.	.	.	.	.	*
" Sowerbyii.	M'C. Pal. Fos. 263.	Aymestry.	.	.	.	.	*	.	.	.	.	.	*
" spinosa.	Phil. Pal. Fos. 48.	Woodabay.	.	.	.	.	*	.	.	.	.	.	.
" subfalcata[k].	M'C. Pal. Fos. 263.	Benson Knot, Llandilo.	.	.	.	.	*	*	.	.	.	.	.
" sublaevis.	M'C. Sil. Fos. 23.	Boocaun.	.	.	.	.	.	.	.	*	.	.	.
" tenuistriata.	M'C. Pal. Fos. 263.	Ludlow, Llandilo.	.	.	.	.	*	*	.	.	.	.	*
DIMYARIA.													
Anodontopsis angustifrons.	M'C. Pal. Fos. 271.	Benson Knot.	.	.	.	.	*	.	.	.	.	.	.
" bulla[l].	M'C. Sil. Fos. 17.	Kirkby Moor, Tonlegee.	.	.	.	.	*	.	.	*	.	.	.
" laevis[m].	Sow. Sil. Sys. 602.	Horeb Chapel.	*	.	.	1	.	*	.	.	.	.	.
" perovalis.	Salt. G. Sur. ii. 268.	Usk.	.	.	.	.	*	.	.	.	.	.	.
" quadratus.	M'C. Pal. Fos. 272.	Storm Hill, Llandilo.	.	.	.	.	.	*	.	.	.	.	.
" securiformis.	M'C. Pal. Fos. 272.	Benson Knot.	.	.	.	.	*	.	.	.	.	.	.
Arca primitiva.	Phil. G. Sur. ii. 268.	Freshwater East.	.	.	.	1	*	.	.	.	.	.	.
Cardiola fibrosa.	Sow. Sil. Sys. 617.	Ludlow, Llandilo.	*	.	.	1	.	*	.	.	.	.	.
" interrupta[n].	Sow. Sil. Sys. 617.	Aymestry, Ferriters.	*	.	4	1	*	**	.	.	.	.	*
" semirugata[o].	Port. G. Rep. 430.	Lisbellaw.	.	.	.	.	.	.	*	.	.	.	.
" striata[p].	Sow. Sil. Sys. 614.	Aymestry, Llandilo.	*	.	3	.	*	*	.	.	.	.	.
Clidophorus ovalis.	M'C. Pal. Fos. 273.	Plas Madoc.	.	.	.	.	.	*	.	.	.	.	.
" planulatus.	Conr. Pal. Fos. 273.	Goldengrove, Llandilo.	.	.	.	.	.	*	.	.	.	.	.
Ctenodonta ambigua[q].	Port. G. Rep. 430.	Tirnaskea.	.	.	.	.	.	.	*	.	.	.	.
" Anglica[r].	Sow. Sil. Sys. 609.	Trewerne Hills, Kendal.	*	.	3	1	*	.	.	.	.	.	.
" deltoidea.	Phil. G. Sur. ii. 366.	Eastnor Park.	.	.	.	.	.	*	.	.	.	.	.
" dissimilis[s].	Port. G. Rep. 428.	Tirnaskea.	.	.	.	.	.	.	*	.	.	.	.
" Eastnori[t].	Sow. Sil. Sys. 635.	Llandilo, Tirnaskea.	.	*	1	1	.	.	*	.	.	.	.
" Edmondiiformis[u].	M'C. Pal. Fos. 288.	Kendal.	.	.	.	.	*	.	.	.	.	.	.

[a] Uncites gryphus.
[b] Inoceramus transversus.
[c] Inoceramus trigona.
[d] Av. posidoniaformis.
[e] Avicula ampliata.
[f] Avicula lineata.
[g] Avicula pleuroptera.
[h] Avicula squamosa.
[i] Avicula reticulata.
[j] Avicula reticulata.
[k] Avicula subfalcata.
[l] Lucina bulla.
[m] Pullastra laevis.
[n] Cardium cornucopiae.
[o] Mytilus semirugata.
[p] Cardium striatum.
[q] Pectunculus Apjohni.
[r] Nucula ovalis.
[s] Arca dissimilis.
[t] Arca Eastnori.
[u] Arca Edmondiiformis.

Name.	Authority.	Locality.	Mur. Upper.	Mur. Lower.	Phil. Upper.	Phil. Lower.	Sedg. Upper.	Sedg. Lower.	Irish, M'Coy. Tyrone.	Irish, M'Coy. Galway.	Irish, M'Coy. Kild. Dubl.	Irish, M'Coy. W. W. W.	Irish, M'Coy. Kerry.
DIMYARIA—*continued.*													
Ctenodonta grandæva[a].	M'C. Sil. Fos. 18.	Tonlegee, Boocaun.								*			
" levata[b].	M'C. Pal. Fos. 285.	Denbighshire.		*			*						
" lævia.	Sow. Sil. Sys. 635.	Pensarn.				1							
" lineata.	Phil. Pal. Fos. 39.	Baggy Point.					*					*	
" lingualis.	Phil. G. Sur. ii. 367.	Eastnor Park.					*						
" obliqua[c].	Port. G. Rep. 429.	Tirnaskea.							*	*			
" ovalis.	Sow. Sil. Sys. 609.	Treweme Hills.	*		3	1							
" plicata.	Phil. Pal. Fos. 38.	Baggy Point.					*						
" poststriata[d].	M'C. Pal. Fos. 397.	Denbighshire.					*						
" Protei.	M'C. Sil. Fos. 19.	Tirnaskea.							*				
" pullastriformis[e].	M'C. Pal. Fos. 397.	Marwood.					*						
" quadrata[f].	M'C. Sil. Fos. 20.	Tirnaskea.							*				
" radiata[g].	Port. G. Rep. 430.	Bardahessia.							*				
" regularis[h].	Port. G. Rep. 427.	Tirnaskea.							*				
" rhomboidea.	Phil. G. Sur. ii. 327.	Eastnor Park.					*						
" scitula[i].	M'C. Sil. Fos. 20.	Lisbellaw.							*				
" semitruncata[j].	Port. G. Rep. 429.	Tirnaskea.							*				
" subacuta[k].	M'C. Sil. Fos. 19.	Tirnaskea.							*				
" subæqualis[l].	M'C. Pal. Fos. 283.	Llechelawdd, Eastnor.					*	*					
" subcylindrica[m].	M'C. Sil. Fos. 19.	Tonlegee.								*			
" transversa[n].	Port. G. Rep. 428.	Tirnaskea.							*				
" varicosa.	Salt. Sil. 213.	Llandilo?						*					
Cucullæa angusta.	Phil. Pal. Fos. 41.	Marwood.					*						
" depressa.	Phil. Pal. Fos. 42.	Marwood.					*						
" Hardingii.	Phil. Pal. Fos. 40.	Marwood.					*						
" trapezium.	Phil. Pal. Fos. 41.	Marwood.					*						
" unilateralis.	Phil. Pal. Fos. 41.	Marwood.					*						
Cucullella Anglica.	Salt. Sil. 50.	Stiper Stones.						*					
" antiqua[o].	Sow. Sil. Sys. 602.	Horeb Chapel, Storm Hill.	*		4	2		*	*	*			
" Cawdori.	Sow. Sil. Sys. 602.	Freshwater East.	*		2	2							
" coarctata[p].	M'C. Pal. Fos. 284.	Benson Knot, Dinas Bran.				1	*	*					*
" ovata[q].	Sow. Sil. Sys. 602.	Horeb Chapel, Pilton.	*		2	2	*	*	*	*			
Cypricardia Phillipsia.	Phil. Pal. Fos. 36.	Baggy Point.					*						
Dolabra elliptica.	M'C. Pal. Fos. 269.	Llandilo.						*					
" obtusa.	M'C. Pal. Fos. 270.	Storm Hill, Llandilo.						*					
Goniophora cymbæformis[r].	Sow. Sil. Sys. 602.	Ludlow, Felindre.	*		5	3		*		*			
Grammysia cingulata[s].	Salt. G. Sur. ii. 360.	Dudley, Storm Hill.			1	1	*	*					
" extrasulcata[t].	Salt. G. Sur. ii. 361.	Benson Knot, Llandilo.				1	*	*					
" rotundata[u].	M'C. Pal. Fos. ii. 281.	Benson Knot.					*						
" triangulata.	Salt. G. Sur. ii. 361.	Benson Knot, Llandilo.					*	*					
Lyrodesma cuneata.	Phil. G. Sur. ii. 366.	Marloes Bay.				2							
" plana.	M'C. Pal. Fos. 272.	Yspatty Evan.						*					
Modiolopsis antiqua[v].	Sow. Sil. Sys. 628.	Ludlow, May Hill.	*		1			*					
" Brycei.	Port. G. Rep. 425.	Tirnaskea.							*				
" complanata[w].	Sow. Sil. Sys. 609.	Linley, Bridgenorth.	*		1	2	*	*					
" expansa[x].	Port. G. Rep. 425.	Tirnaskea, Wales.						*	*				
" gradata[y].	Salt. G. Sur. ii. 363.	Shropshire.			2	1	*						
" inflata.	M'C. Pal. Fos. 266.	Bala, Pen Cerrig.						*					
" modiolaris.	M'C. Pal. Fos. 267.	Aber Hirnant.						*					
" Nerei.	Port. G. Rep. 424.	Bardahessia.							*				
" obliqua.	Sow. Sil. Sys. 635.	Caradoc, Soudley.		*									
" orbicularis.	Sow. Sil. Sys. 635.	Horderly.		*									
" provalis.	Salt. G. Sur. ii. 363.	Llanbadoc, Usk.			2		*						
" platyphylla[z].	Salt. G. Sur. ii. 364.	Storm Hill, Llandilo.						*					
" postlineata.	M'C. Pal. Fos. 268.	Bala, Alt y Anker.						*					
" quadrata.	Salt. G. Sur. ii. 363.	Dafaddhfa Ushat.				1	*						
" securiformis.	Port. G. Rep. 425.	Tirnaskea.							*				

[a] Nucula grandæva.
[b] Nucula levata.
[c] Arca obliqua.
[d] Nuculites poststriatus.
[e] Pullastra antiqua.
[f] Arca quadrata.
[g] Arca radiata.
[h] Arca regularis.
[i] Arca scitula.
[j] Pectunculus semitruncata.
[k] Nucula subacuta.
[l] Arca subæqualis.
[m] Nucula subcylindrica.
[n] Arca subtruncata.
[o] Cucullæa antiqua.
[p] Nucula coarctata.
[q] Cucullæa ovata.
[r] Cypricardia cymbæformis.
[s] Nucula cingulata.
[t] Orthonota extrasulcata.
[u] Mya rotundata.
[v] Modiola antiqua.
[w] Pullastra complanata.
[x] Modiola expansa.
[y] Mod. Nilssoni.
[z] Mytilus platyphilla.

Name.	Authority.	Locality.	Mur. Upper.	Mur. Lower.	Phil. Upper.	Phil. Lower.	Sedg. Upper.	Sedg. Lower.	Irish, M'Coy. Tyrone.	Irish, M'Coy. Galway.	Irish, M'Coy. Kild. Dubl.	Irish, M'Coy. W. W. W.	Irish, M'Coy. Kerry.
DIMYARIA—*continued.*													
Mytilus Chemungensis.	Salt. G. Sur. ii. 365.	Usk.	.	.	.	.	*	.	.	.	.	.	.
" cinctus.	Port. G. Rep. 426.	Lisbellaw, Tirnaskea.	.	.	.	.	.	.	*	.	.	.	.
" exasperatus.	Phil. G. Sur. ii. 364.	Llandilo.	.	.	.	1	.	.	.	.	.	.	.
" mytilimeris.	Salt. G. Sur. ii. 364.	Dudley, Llandilo.	.	.	2	1	.	.	.	.	*	.	*
" unguiculatus.	Salt. G. Sur. ii. 365.	Bryn Craig, Usk.	.	.	1	.	*	.	.	.	.	.	.
Nucula latissima.	Phil. Pal. Fos. 137.	Pilton.	.	.	.	.	*	.	.	.	.	.	.
Orthonota amygdalina[a].	Sow. Sil. Sys. 609.	Ludlow, Marwood.	*	.	5	2	*	.	.	.	.	.	.
" angulifera[b].	M'C. Pal. Fos. 276.	Benson Knot.	.	.	.	.	*	.	.	.	.	.	.
" globulosa[c].	M'C. Pal. Fos. 278.	Benson Knot.	.	.	.	.	*	.	.	.	.	.	.
" impressa[d].	Sow. Sil. Sys. 609.	Aymestry, Boocaun.	*	.	1	3	*	.	*	*	.	.	.
" nasuta[e].	Conr. M'C. P.F. 275.	Horderly, West.	.	.	.	.	.	*	.	.	.	.	.
" prora[f].	Salt. Sil. 254.	Kilbride, Mulock.	.	.	.	.	*	*	.	**	.	.	.
" rigida.	Sow. Sil. Sys. 617.	Aymestry, Tullyconnor.	*	.	3	1	.	.	.	*	.	.	.
" rotundata[g].	Sow. Sil. Sys. 613.	Caynham Camp, Lud.	*	.	3	1	.	.	.	*	.	.	*
" semisulcata[h].	Sow. Sil. Sys. 617.	Builth, Aymestry.	*	.	1	1	.	.	.	**	.	.	.
" solenoides[i].	Sow. Sil. Sys. 617.	Ludlow, Boocaun.	*	.	4	.	*	*	.	*	.	.	.
" truncata[j].	M'C. Pal. Fos. 279.	Benson Knot.	.	.	.	.	*	.	.	.	.	.	.
" undata[k].	Sow. Sil. Sys. 609.	Aymestry.	*	.	.	.	*	.	.	.	.	.	.
Pleurorhynchus æquicostatus[l].	Phil. G. Sur. ii. 359.	Dudley, N. Wales.	.	.	1	.	*	*	.	.	.	.	.
" dipterus.	Salt. Sil. 213.	Ayrshire.	.	.	.	.	.	*	.	.	*	.	.
" pristis.	Salt. Sil. Fos. 71.	Ardaun.	.	.	.	.	.	.	.	*	.	.	.
Sanguinolites complanatus[m].	Phil. Pal. Fos. 35.	Pilton, Marwood.	.	.	.	.	*	.	.	.	.	.	.
" liratus.	Phil. Pal. Fos. 136.	Pilton.	.	.	.	.	*	.	.	.	.	.	.
GASTEROPODA.													
Acroculia euomphaloides[n].	M'C. Pal. Fos. 290.	Leintwardine.	.	.	.	.	*	.	.	.	.	.	*
" Haliotis[o].	Sow. Sil. Sys. 625.	Ledbury, Doonquin.	*	.	3	2	*	.	.	.	.	.	*
" prototypa[p].	Phil. G. Sur. ii. 259.	Ledbury.	.	.	2	.	.	.	.	.	.	.	.
" vetusta.	Sow. Sil. Sys. 616.	Newton, Aymestry.	*	.	.	1	.	.	.	.	.	.	.
Chiton Grayanus[q].	Kon. Salt. S. F. 71.	Coolin.	.	.	.	.	.	.	.	*	.	.	.
Cyclonema concinna[r].	M'C. Sil. Fos. 12.	Carrickadaggan.	.	.	.	.	.	.	.	.	.	*	.
" corallii[s].	Sow. Sil. Sys. 612.	Trewerne Hills.	*	.	.	.	*	.	.	.	.	.	*
" crebristria[t].	M'C. Pal. Fos. 295.	Mandinam, Bala.	.	.	.	.	.	*	.	.	.	.	.
" octavia[u].	Sow. Sil. Sys. 612.	Trewerne Hills.	*	.	.	.	*	.	.	.	.	.	.
" quadristriata.	Phil. M. G. S. 388.	Malvern.	.	.	1	.	.	.	.	.	.	.	.
" rupestris[v].	Eichw. Salt. Sil. 215.	?	.	.	.	.	.	*	.	.	*	.	.
" sulcifera.	Eich. Urw. Russ. t. 2.	Tyrone (Mur.)	.	.	.	.	.	.	*	.	.	.	.
" undifera[w].	M'C. Pal. Fos. 306.	Aymestry.	.	.	.	.	*	.	.	.	.	.	.
" ventricosa.	Hall P. N. Y. ii. 90.	?	.	.	.	.	.	*	.	.	.	.	.
Euomphalus alatus.	Sow. Sil. Sys. 631.	Delves Green, Ferriter's.	*	.	4	1	.	.	.	.	.	.	*
" carinatus.	Sow. Sil. Sys. 616.	Aymestry.	*	.	1	.	.	.	.	.	.	.	.
" centrifugus[x].	M'C. Pal. Fos. 297.	Leintwardine.	.	.	.	.	*	.	.	.	.	.	.
" corndensis.	Sow. Sil. Sys. 641.	Corndon Hills.	.	*	1	.	.	.	.	.	.	.	.
" discors.	Sow. Sil. Sys. 626.	Dudley, Wenlock.	*	.	2	1	*	.	.	.	.	.	.
" funatus.	Sow. Sil. Sys. 626.	Dudley, Corndon.	*	*	5	1	*	*	.	*	.	.	*
" lautus.	M'C. Sil. Fos. 14.	Ferriter's Cove.	.	.	.	.	.	.	.	.	.	.	*
" prænuntius.	Phil. G. Sur. ii. 357.	Gunwick Mill.	.	.	2	1	.	.	.	.	.	.	.
" rugosus.	Sow. Sil. Sys. 626.	Dudley, Wenlock.	*	.	.	.	*	.	.	.	.	.	.
" sculptus.	Sow. Sil. Sys. 626.	Ledbury, Tirnaskea.	*	.	3	4	*	.	*	*	.	*	*
" tenuistriatus[y].	Sow. Sil. Sys. 641.	Corndon, Doonquin.	.	*	.	1	.	.	.	.	.	.	*
Holopæa concinna[z].	M'C. Sil. Fos. 13.	Carrickadaggan.	.	.	.	.	.	.	.	.	*	*	.
" striatella[aa].	Sow. Sil. Sys. 642.	Horderly.	.	*	2	2	.	.	.	.	.	.	.
Holopella cancellata[bb].	Sow. Sil. Sys. 642.	Mandinam.	.	*	2	1	*	.	.	.	.	.	.

[a] Cypricardia amygdalina.
[b] Sanguinolites angulifera.
[c] Leptodomus globulosus.
[d] Cypricardia impressa.
[e] Modiolopsis nasuta.
[f] O. semisulcata.
[g] Mya rotundata.
[h] Modiola semisulcata.
[i] Cypricardia solenoides.
[j] Leptodomus truncata.
[k] Cypricardia undata.
[l] Conocardium æquicostatus.
[m] Pullastra complanata.
[n] Capulus euomphaloides.
[o] Nerita Haliotis.
[p] Nerita prototypa.
[q] Helminthochiton Griffithii.
[r] Turbo concinna.
[s] Turbo corallii.
[t] Turbo crebristria.
[u] Turbo carinatus.
[v] Trochus rupestris.
[w] Litorina undifera.
[x] Euom. substriatus.
[y] Bell. perturbatus.
[z] Naticopsis concinna.
[aa] Trochus constrictus.
[bb] Turritella cancellata.

Name.	Authority.	Locality.	Mur. Upper.	Mur. Lower.	Phil. Upper.	Phil. Lower.	Sedg. Upper.	Sedg. Lower.	Irish, M'Coy. Tyrone.	Irish, M'Coy. Galway.	Irish, M'Coy. Kild. Dubl.	Irish, M'Coy. W. W. W.	Irish, M'Coy. Kerry.
GASTEROPODA—cont.													
Holopella conica[a].	Sow. Sil. Sys. [illegible]	Horeb Chapel, Felindre.	•	.	.	1	.	.	.	•	.	.	.
" gracilior.	M'C. Pal. Fos. [illegible]	Pembrokeshire.	.	.	.	.	•	.	.	.	.	.	.
" gregaria[b].	Sow. Sil. Sys. [illegible]	Horeb Chapel.	•	.	1	3	.	•	.	•	.	.	.
" intermedia.	M'C. Pal. Fos. 304.	Underbarrow.	.	.	.	.	•	.	.	.	.	.	.
" [illegible]	M'C. Pal. Fos. 304.	[illegible] Road.	.	.	.	.	.	•	.	.	.	.	.
" obsoleta[c].	Sow. Sil. Sys. [illegible]	Horeb Chapel, Felindre.	•	.	2	1	.	•	.	•	.	.	.
" plana.	M'C. Sil. Fos. 12.	Tonlegee.	.	.	.	.	.	.	.	•	.	.	.
" tenuicincta.	M'C. Pal. Fos. 304.	[illegible], Ayrshire.	.	.	.	.	.	•	.	.	.	.	.
Loxonema elegans.	M'C. Pal. Fos. 302.	Leintwardine.	.	.	.	.	•	.	.	.	.	.	.
" sinuosa.	Sow. Sil. Sys. 619.	Aymestry.	•	.	1	2	.	.	.	.	.	.	•
Macrocheilus elongatus[d].	Port. G. Rep. 415.	Desertcreat.	.	.	.	.	.	.	•	.	.	.	.
" fusiformis.	Sow. Sil. Sys. 642.	Corton.	.	•	.	.	.	.	.	.	.	.	.
Murchisonia angulata[e].	Sow. Sil. Sys. 641.	Mandinam.	.	•	1	1	.	.	.	.	.	•	.
" angustata.	Hall, M'C. Pal. Fos. 292.	Ayrshire.	.	.	.	.	.	•	.	.	.	.	.
" articulata[f].	Sow. Sil. Sys. 612.	Ludlow, Tonlegee.	•	.	3	2	.	.	.	•	.	.	.
" balteata[g].	Phil. G. Sur. ii. 358.	May Hill, Llandilo.	.	.	1	1	.	.	.	.	.	.	.
" bicincta.	M'C. Sil. Fos. 16.	Kildare.	.	.	.	.	.	.	.	.	•	.	.
" cancellatula.	M'C. Pal. Fos. 292.	Meifod, Ayrshire.	.	.	.	.	.	•	.	.	.	.	.
" cingulata.	M'C. Pal. Fos. 293.	Kilbride, Aymestry.	.	.	.	.	•	.	.	•	.	.	.
" corallii.	Sow. Sil. Sys. 612.	Ludlow, Knockmahon.	•	.	3	1	.	.	.	.	.	•	•
" gyrogonia.	M'C. Pal. Fos. 293.	Yspytty Evan.	.	.	.	.	.	•	.	.	.	.	.
" inflata[h].	M'C. Sil. Fos. 15.	Tonlegee.	.	.	.	.	.	.	.	•	.	.	.
" Lloydii[i].	Sow. Sil. Sys. 619.	Shelderton Hill.	•	.	4	2	•	.	.	.	.	.	.
" obscura.	Port. G. Rep. 415.	Tirnaskea.	.	.	.	.	.	.	•	.	.	.	.
" Prycea.	Sow. Sil. Sys. 642.	Mandinam.	.	•	2	2	.	.	.	.	.	.	.
" pulchra.	M'C. Sil. Fos. 16.	Glencraff, Ayrshire.	.	.	.	.	.	•	.	•	.	.	.
" simplex.	M'C. Pal. Fos. 294.	Ayrshire.	.	.	.	.	.	•	.	.	.	•	.
" subrotundata[j].	Port. G. Rep. 414.	Desertcreat.	.	.	.	.	.	.	•	.	.	.	.
" sulcata.	M'C. Sil. Fos. 17.	Uggool.	.	.	.	.	.	.	.	•	.	.	.
" torquata.	M'C. Pal. Fos. 294.	Benson Knot.	.	.	.	.	•	.	.	.	.	.	.
" turrita[k].	Port. G. Rep. 413.	Tirnaskea, Bala.	.	.	.	.	.	•	•	.	.	.	.
Natica meridionalis.	Phil. Pal. Fos. 94.	Baggy Point.	.	.	.	.	•	.	.	.	.	.	.
" parva[l].	Sow. Sil. Sys. 612.	Fownhope, Woolhope.	•	.	1	1	.	.	.	.	.	.	.
Ophileta compacta.	Salt. Sil. 217.	W. Highlands.	.	.	.	.	.	•	.	.	.	.	.
" macromphala[m].	M'C. Pal. Fos. 300.	Craig Head, Ayr.	.	.	.	.	.	•	.	.	.	.	.
Patella saturni.	Port. G. Rep. 416.	Tirnaskea.	.	.	.	.	.	.	•	.	.	.	.
Platyschisma helicites[n].	Sow. Sil. Sys. 603.	Horeb Chapel.	•	.	.	2	.	.	.	•	.	.	.
" Williamsi[o].	Sow. Sil. Sys. 603.	Horeb Chapel.	•	.	.	2	•	.	.	.	.	.	.
Pleurotomaria aspera.	Phil. Pal. Fos. 96.	Woodabay, Pilton.	.	.	.	.	•	.	.	.	.	.	.
" crenulata.	M'C. Pal. Fos. 291.	Brigsteer.	.	.	.	.	•	.	.	.	.	.	.
" expansa.	Phil. Pal. Fos. 97.	Baggy Point.	.	.	.	.	•	.	.	.	.	.	.
" fissicarina.	Phil. G. Sur. ii. 357.	Malvern.	.	.	1	.	•	.	.	.	.	.	.
" gracilis.	Phil. Pal. Fos. 98.	Baggy Point, Brushford.	.	.	.	.	•	.	.	.	.	.	.
" latifasciata.	M'C. Sil. Fos. 15.	Tirnaskea.	.	.	.	.	.	.	•	.	.	.	.
" trochiformis.	Port. G. Rep. 414.	Tirnaskea, Ferritera.	.	.	.	.	.	.	•	.	.	.	•
" undata.	Sow. Sil. Sys. 619.	Ludlow, Leintwardine.	•	.	1	.	•	.	.	.	.	.	.
Raphistoma equalis[p].	Salt. G. Sur. ii. 356.	Llandilo.	.	.	.	1	.	.	.	.	.	.	.
" elliptica[q].	Port. G. Rep. 414.	Desertcreat, Uggool.	.	.	.	.	.	.	•	•	.	.	.
" lenticularis[r].	Sow. Sil. Sys. 642.	Storridge Hill.	.	•	1	.	•	•	.	.	.	.	.
Trochonema latifasciata[s].	M'C. Sil. Fos. 15.	Desertcreat.	.	.	.	.	.	.	•	.	.	.	.
" lyrata[t].	M'C. Pal. Fos. 298.	Llansantfraid.	.	.	.	.	•	.	.	.	.	.	.
" tricincta[u].	M'C. Sil. Fos. 14.	Lettershanbally.	.	.	.	.	.	•	.	•	.	.	.
" triporcata[v].	M'C. Pal. Fos. 299.	Goldengrove.	.	.	.	.	.	•	.	.	.	.	.
" trochleata[w].	M'C. Sil. Fos. 12.	Boocaun, Tonlegee.	.	.	.	.	.	.	.	•	.	.	.
Trochus cælatulus.	M'C. Pal. Fos. 296.	Old Radnor.	.	.	.	.	.	.	•	.	.	.	.
" Moorei.	M'C. Pal. Fos. 297.	Dalquhorran, Ayr.	.	.	.	.	.	.	.	•	.	.	.
" multitorquatus.	M'C. Sil. Fos. 15.	Boocaun, Tonlegee.	.	.	.	.	.	.	.	•	.	.	.

[a] Turritella conica.
[b] Turritella gregaria.
[c] Turritella obsoleta.
[d] Polyphemus elongatus.
[e] Pleurotomaria angulata.
[f] Pleurotoma articulata.
[g] Pleurotomaria balteata.
[h] Pleurotomaria inflata.
[i] Pleurotomaria Lloydi.
[j] Pleurotomaria subrotundata.
[k] Pleurotomaria turrita.
[l] Nat. glaucinioides.
[m] Maclurea macromphala.
[n] Trochus helicites.
[o] Turbo Williamsii.
[p] Euomphalus qualteriatus.
[q] Trochus elliptica.
[r] Trochus lenticularis.
[s] Pleurotomaria latifasciata.
[t] Euomphalus lyrata.
[u] Euomphalus tricincta.
[v] Euomphalus triporcata.
[w] Turbo trochleata.

Name.	Authority.	Locality.	Mur. Upper.	Mur. Lower.	Phil. Upper.	Phil. Lower.	Sedg. Upper.	Sedg. Lower.	Irish, M'Coy. Tyrone.	Galway.	Kild. Dubl.	W. W. W.	Kerry.
GASTEROPODA—*cont.*													
Turbo cirrhosus.	Sow. Sil. Sys. 631.	Wenlock.	*	.	1	.	.	.	.	.	.	.	.
„ tritorquatus.	M'C. Sil. Fos. 12.	Boocaun, Kildare.	.	.	.	.	.	.	.	*	*	.	.
HETEROPODA.													
Bellerophon acutus.	Sow. Sil. Sys. 643.	Horderly.	.	*	.	1	.	.	.	.	.	.	.
„ alatus.	Port. G. Rep. 471.	Bardahessia.	.	.	.	.	.	.	*	.	.	.	.
„ bilobatus[a].	Sow. Sil. Sys. 643.	Welchpool, Tirnaskea.	.	*	1	1	.	*	*	*	.	.	.
„ carinatus.	Sow. Sil. Sys. 604.	Horeb Chapel, Tonlegee.	*	.	1	1	.	*	.	*	.	.	.
„ dilatatus.	Sow. Sil. Sys. 627.	Aymestry, Tirnaskea.	*	.	1	1	.	*	*	*	.	.	.
„ expansus[b].	Sow. Sil. Sys. 613.	Ludlow, Tonlegee.	*	.	1	1	*	*	.	*	.	.	.
„ Murchisoni[c].	Sow. Sil. Sys. 604.	Horeb Chapel, Felindre.	*	.	1	1	.	*	.	.	.	.	.
„ nodosus.	Salt. G. Jour. x. 73.	Bala.	.	.	.	.	.	*	.	.	.	.	.
„ obtectus.	Phil. G. Sur. ii. 356.	Marloes Bay.	.	.	.	1	.	.	.	.	.	.	.
„ perturbatus[d].	Sow. Sil. Sys. 651.	Pensarn, Greenville.	.	*	.	.	.	.	.	.	.	*	*
„ striatus.	Bronn. Sil. Sys. 604.	Woodabay, Felindre.	*	.	.	.	*	.	.	.	.	.	.
„ subdecupatus.	M'C. Pal. Fos. 311.	Girvan, Mulock.	.	.	.	.	.	*	.	.	.	.	.
„ subglobatus.	Phil. Pal. Fos. 108.	Woodabay, Marwood.	.	.	.	.	*	.	.	.	.	.	.
„ sulcatinus.	Salt. G. Jour. x. 74.	Horderly, Tyrone.	.	.	.	.	.	*	*	.	.	.	.
„ trilobatus.	Sow. Sil. Sys. 604.	Felindre, Baggy Point.	*	.	1	1	.	*	.	**	.	.	.
„ Urii.	Phil. Pal. Fos. 106.	Baggy Point, Pilton.	.	.	.	.	*	.	.	.	.	.	.
„ Wenlockensis.	Sow. Sil. Sys. 627.	Wenlock, Ledbury.	*	.	1	1	*	.	.	.	.	.	*
PTEROPODA.													
Conularia elongata.	Port. G. Rep. 393.	Tirnaskea.	.	.	.	.	.	.	*	.	.	.	.
„ Sowerbyi.	Sow. Sil. Sys. 626.	Dudley, Bala.	*	.	.	.	*	*	.	.	.	.	.
„ sublilis.	Salt. Pal. Fos. 288.	Benson Knot.	.	.	.	.	*	.	.	.	.	.	.
Ecculiomphalus Bucklandi[e].	Port. G. Rep. 411.	Tirnaskea.	.	.	.	.	.	.	*	*	.	.	.
„ lævis[f].	Sow. Sil. Sys. 621.	Abberley.	*	.	3	1	.	.	.	.	.	.	.
„ Scoticus.	M'C. Pal. Fos. 301.	Mullock Quarry.	.	.	.	.	.	*	.	.	.	.	.
Maclurea Logani.	Salt. G. Sur. vii.	Aldians, Ayr.	.	.	.	.	.	*	.	.	.	.	.
„ magna.	M'C. Pal. Fos. 300.	Knockdollian.	.	.	.	.	.	*	.	.	.	.	.
„ Peachii.	Salt. Sil. 217.	?	.	.	.	.	.	.	.	.	.	.	.
Pterotheca corrugata.	Salt. Br. Ass. 1852, 61.	?	.	.	.	.	.	*	.	.	.	.	.
„ transversa.	Port. G. Rep. 455.	Desertcreat.	.	.	.	.	.	.	*	.	.	.	.
Theca anceps.	Salt. G. Sur. ii. 355.	Eastnor Park.	.	.	.	.	*	.	.	.	.	.	.
„ Forbesii.	Sharpe, G. J. ii. 314.	Usk, Dinas Bran.	.	.	.	.	*	.	.	.	.	.	.
„ reversa.	Salt. Sil. 55.	Lampeter Felfry ?	.	.	.	.	.	*	.	.	.	.	.
„ simplex.	Salt. Sil. 50.	Ritton Castle ?	.	.	.	.	.	*	.	.	.	.	.
„ triangularis.	Port. G. Rep. 375.	Desertcreat.	.	.	.	.	.	.	*	.	.	.	.
„ vaginula.	Salt. Sil. 53.	Ritton Castle.	.	.	.	.	.	*	.	.	.	.	.
CEPHALOPODA.													
Ascoceras Barrandii	Salt. Sil. 259.	Usk.	.	.	.	.	*	.	.	.	.	.	.
Cyrtoceras approximatum.	Sow. Sil. Sys. 642.	Eastnor Park.	.	*	1	.	.	.	.	.	.	.	.
„ inequiseptum[g].	Port. G. Rep. 382.	Desertcreat.	.	.	.	.	.	.	*	.	.	.	.
„ multicameratum.	M'C. Pal. Fos. 312.	Ayrshire.	.	.	.	.	.	*	.	.	.	.	.
Lituites anguiformis[h].	Salt. P. Fos. Ap. viii.	Denbighshire.	.	.	.	.	.	*	.	.	.	.	.
„ articulatus.	Sow. Sil. Sys. 622.	Ludlow.	*	.	.	.	*	.	.	.	.	.	.
„ Biddulphii.	Sow. Sil. Sys. 626.	Ledbury.	*	.	1	.	*	.	.	.	.	.	.
„ cornuarietis.	Sow. Sil. Sys. 643.	Corton, Tirnaskea.	.	*	.	1	.	*	*	.	.	.	.
„ giganteus.	Sow. Sil. Sys. 622	Mocktree Hays.	*	.	3	1	*	*	.	.	.	.	.
„ Hibernicus.	Salt. Sil. 220.	?	.	.	.	.	.	*	.	.	.	.	.
„ planorbiformis[i].	M'C. Pal. Fos. 324.	Cymmerig Brook, Bala.	.	.	.	.	.	*	.	.	.	.	.
„ tortuosus.	Sow. Sil. Sys. 622.	Welchpool.	*	.	.	.	.	.	.	.	.	.	.
„ undosus.	Sow. Sil. Sys. 642.	Llandilo	.	*	.	1	.	.	.	.	.	.	.
Orthoceras angulatum[j].	Sow. Sil. Sys. 620.	Bagbarrow Hill.	*	.	4	2	.	.	.	.	.	.	*
„ annulatum[k].	Sow. Sil. Sys. 632.	Stumps Wood.	*	*	4	2	.	*	.	.	.	.	.
„ arcuoliratum.	M'C. P. Fos. 319.	Wræ Quarry, Scotland.	.	.	.	.	.	*	.	.	.	.	.

[a] Bell. gibbus.
[b] Bell. globatus.
[c] Bel. striatus.
[d] Enom. furcatus.
[e] Cyrtolites Bucklandi.
[f] Cyrt. lævis.
[g] Phragmoceras Brateri.
[h] Trocholites anguiformis.
[i] Nautilus primævus.
[j] O. virgatum.
[k] O. undulatum.

Name.	Authority.	Locality.	Mur. Upper.	Mur. Lower.	Phil. Upper.	Phil. Lower.	Sedg. Upper.	Sedg. Lower.	Irish, M'Coy. Tyrone.	Galway.	Kild. Dubl.	W. W. W.	Kerry.
CEPHALOPODA—*cont.*													
Orthoceras attenuatum.	Sow. Sil. Sys. 622.	Banks of Onny.	*	.	.	.	.	.	.	.	.	.	.
" Avelinii.	Salt. Sil. 50.	Stiper Stones W.	.	.	.	.	.	*	.	.	.	.	.
" baculiforme[a].	Salt. P. Fos. Ap. p. vi.	Brigsteer, Kildare.	.	.	.	.	*	.	.	.	*	.	.
" Barrandii.	Salt. G. Jour. vii. 177.	Mulock, Ayr, Tirnaskea.	.	.	.	.	.	*	*	.	.	.	.
" bilineatum[b].	M'C. Pal. Fos. 319.	Girvan, Ayr.	.	.	.	.	.	*	*	.	.	.	.
" brevicornicum.	Port. G. Rep. 373.	Tirnaskea.	.	.	.	.	.	.	*	.	.	.	.
" Brongniartii.	Port. G. Rep. 368.	Desertcreat.	.	.	.	.	.	.	*	.	.	.	.
" bullatum[c].	Sow. Sil. Sys. 604.	Malverns, Llandilo.	*	.	5	3	*	*	.	*	.	.	*
" canaliculatum.	Sow. Sil. Sys. 622.	Ledbury.	*	.	.	1	.	.	.	.	.	.	.
" centrale.	M'C. Pal. Fos. 319.	Kendal, Llandilo.	.	.	.	.	*	*	.	.	.	.	.
" coralliforme.	M'C. Sil. Fos. 4.	Blackwater.	.	.	.	.	.	.	.	*	.	.	.
" dimidiatum.	Sow. Sil. Sys. 620.	Radnor Forest.	*	.	.	.	*	.	.	.	.	.	.
" distans.	Sow. Sil. Sys. 619.	Aymestry.	*	.	.	.	.	.	.	.	.	.	.
" encrinale.	Salt. Sil. 50.	Stiper Stones W.	.	.	.	.	.	*	.	.	.	.	.
" elongatocinctum.	Port. G. Rep. 372.	Tirnaskea.	.	.	.	.	.	.	*	.	.	.	.
" excentricum.	Sow. Sil. Sys. 631.	Old Radnor.	*	.	1	.	.	.	.	.	.	.	.
" filosum.	Sow. Sil. Sys. 620.	Ludlow, Tullyconnor.	*	.	.	.	*	*	.	*	.	.	.
" gregarium.	Sow. Sil. Sys. 619.	Ludlow, Tyrone.	*	.	.	.	.	.	*	*	*	.	.
" ibex[d].	Sow. Sil. Sys. 622.	Ludlow, Marwood.	*	.	5	2	*	*	.	*	.	.	*
" imbricatum.	Sow. Sil. Sys. 620.	Ludlow, Ferriter's.	*	.	3	1	*	.	.	.	.	.	*
" laqueatum.	M'C. Pal. Fos. 315.	Westmoreland.	.	.	.	.	*	*	.	.	.	.	.
" lineolatum.	Phil. Pal. Fos. 111.	Croyde Bay.	.	.	.	.	*	.	.	.	.	.	.
" Ludense[e].	Sow. Sil. Sys. 619.	Ludlow.	*	.	2	.	*	.	.	.	.	.	.
" Maclareni.	Salt. Sil. 176.	Pentland Hills.	.	.	.	.	*	.	.	.	.	.	.
" Marloense.	Phil. G. Sur. ii. 247.	Woolltack Bay.	.	.	.	1	.	.	.	.	.	.	.
" Mocktreense.	Sow. Sil. Sys. 616.	Mocktree, Abberley.	*	.	.	.	*	.	.	.	.	.	.
" nummularium.	Sow. Sil. Sys. 632.	Whitfield Quarry.	*	*	1	.	.	.	.	.	.	.	.
" perannulatum.	Port. G. Rep. 367.	Desertcreat.	.	.	.	.	.	.	*	.	.	.	.
" per-elegans[f].	Salt. Sow. S. Sys. 622.	Ludlow.	*	.	4	1	.	.	.	.	.	.	.
" politum.	M'C. Pal. Fos. 316.	Glenquapple, Ayr.	.	.	.	.	.	*	.	.	.	.	.
" Pomeroense.	Port. G. Rep. 370.	Desertcreat.	.	.	.	1	.	.	*	.	.	.	.
" primaevum[g].	Forbes, G. Jour.	Radnorshire.	.	.	.	.	.	*	.	.	.	.	.
" striatum.	Sow. Sil. Sys. 604.	Horeb Chapel.	*	.	.	.	.	.	.	.	.	.	.
" subgregarium.	M'C. Sil. Fos. 9.	Ardaun, Boocaun.	.	.	.	.	.	.	.	*	.	.	.
" subundulatum[h].	Port. G. Rep. 373.	Tirnaskea, N. Wales.	.	.	.	.	.	*	*	.	.	.	*
" tentaculare.	Phil. Pal. Fos. 112.	Baggy Point, Brushford.	.	.	.	.	*	.	.	.	.	.	.
" tenuiannulatum.	M'C. Pal. Fos. 320.	Shropshire.	.	.	.	.	1	.	.	.	.	.	.
" tenuicinctum.	Port. G. Rep. 371.	Tirnaskea, Bala.	.	.	.	.	.	*	*	*	*	*	.
" tenuistriatum.	M'C. Pal. Fos. 405.	Mulock, Petherwin, Tirnaskea.	.	.	.	.	*	.	*	.	.	.	.
" textile.	Phil. G. Sur. ii. 249.	Freshwater, East.	.	.	.	1	.	.	.	.	.	.	.
" torquatum.	M'C. P. Fos. App. vii.	Kendal.	.	.	.	.	*	.	.	.	.	.	.
" tracheale[i].	Sow. Sil. Sys. 604.	Horeb Chapel.	*	.	1	1	*	.	.	.	.	.	.
" vagans.	M'C. Pal. Fos. 318.	Bala, Coniston.	.	.	.	.	.	*	.	.	.	.	.
" vaginatum.	Salt. G. Jour. vii. 377.	Ardwell.	.	.	.	.	*	.	.	.	.	.	.
" ventricosum[j].	Sharpe, G. J. ii. t. 13.	Saw Mill, Builth.	.	.	.	.	.	*	.	.	.	.	.
Phragmoceras arcuatum[k].	Sow. Sil. Sys. 621.	Leintwardine.	*	.	.	.	*	.	*	.	.	.	.
" compressum.	Sow. Sil. Sys. 621.	Aymestry, Tirnaskea.	*	.	.	1	.	.	*	.	.	.	.
" intermedium.	M'C. Pal Fos. 322.	Leintwardine.	.	.	.	.	*	.	.	.	.	.	.
" nautileum.	Sow. Sil. Sys. 622.	Middleton Hall.	*	.	.	3	.	.	.	.	.	.	.
" pyriforme[l].	Sow. Sil. Sys. 620.	Aymestry.	*	.	2	1	*	.	.	.	.	.	.
" ventricosum.	Sow. Sil. Sys. 621.	Aymestry.	*	.	.	.	*	.	.	.	.	.	.
Poterioceras approximatum[m].	M'C. Sil. Fos. 7.	Letterahanbally.	.	.	.	.	.	.	*	*	.	.	.
Tretoceras bisiphonatum.	Sow. Sil. Sys. 642.	Gorllwynfach.	.	*	.	1	.	.	.	.	.	.	.
" semipartitum.	Sow. Sil. Sys. 604.	Horeb Chapel.	*	.	.	2	.	.	.	*	.	.	.
PISCES.													
Cephalaspis Lyellii.	Ag. Sil. Sys. 589.	Herefordshire.	*	.	.	.	.	.	.	.	.	.	.
" rostratus.	Ag. Sil. Sys. 592.	Whitbatch.	*	.	.	.	.	.	.	.	.	.	.
" Lewisii.	Ag. Sil. Sys. 593.	Whitbatch, Shropshire.	*	.	.	.	.	.	.	.	.	.	.

[a] Ortho. linearis.
[b] O. calamiteum.
[c] Orth. striatum.
[d] O. articulatum.
[e] Orth. distans.
[f] Lituites articulata.
[g] Criseis primaevum.
[h] Criseis Sedgwickii.
[i] O. par-elegans.
[j] Criseis ventricosum.
[k] Phrag. intermedium.
[l] Orthoceras pyriforme.
[m] Orth. subfusiforme.

Name.	Authority.	Locality.	Mur.		Phil.		Sedg.		Irish, M'Coy.				
			Upper.	Lower.	Upper.	Lower.	Upper.	Lower.	Tyrone.	Galway.	Kild. Dubl.	W. W. W.	Kerry.
PISCES—*continued.*													
Cephalaspis Lloydii.	Ag. Sil. Sys. 594.	Hereford.	*	.	.	.	.	.	.	.	.	.	.
Cheiracanthus Murchisoni.	Ag. Sil. Sys. 601.	Gamrie.	*	.	.	.	.	.	.	.	.	.	.
„ minor.	Ag. Sil. Sys. 601.	Stromness, Moray.	*	.	.	.	.	.	.	.	.	.	.
Cheirolepis Traillii.	Ag. Sil. Sys. 601.	Pomona.	*	.	.	.	.	.	.	.	.	.	.
„ uragus.	Ag. Sil. Sys. 601.	Gamrie.	*	.	.	.	.	.	.	.	.	.	.
Ctenacanthus ornatus.	Ag. Sil. Sys. 597.	Abergavenny.	*	.	.	.	.	.	.	.	.	.	.
Dipterus macrolepidotus.	Ag. Sil. Sys. 599.	Downton Castle.	*	.	.	.	.	.	.	.	.	.	.
Holophtychyus Nobillissimus.	Ag. Sil. Sys. 599.	Crickhowell.	*	.	.	.	.	.	.	.	.	.	.
Onchus arcuatus.	Ag. Sil. Sys. 596.	Bromyard.	*	.	.	.	.	.	.	.	.	.	.
„ Murchisoni.	Ag. Sil. Sys. 596.	Southstone rock.	*	.	.	.	.	.	.	.	.	.	.
„ semistriatus.	Ag. Sil. Sys. 607.	Ludlow.		.	.	.	.	.	.	.	.	.	.
„ tenuistriatus.	Ag. Sil. Sys. 607.	Ludlow Bonebed.	*	.	.	.	.	.	.	.	.	.	.
Osteolepis macrolepidotus.	Val. and Pent. Sil. Sys. 601.	Cromarty.	*	.	.	.	.	.	.	.	.	.	.
„ microlepidotus.	Val. and Pent. Sil. Sys. 601.	Caithness.	*	.	.	.	.	.	.	.	.	.	.
Plectrodus mirabilis.	Ag. Sil. Sys. 606.	Ludlow Bonebed.	*	.	.	.	.	.	.	.	.	.	.
Thelodus parvidens.	Ag. Sil. Sys. 606.	Ludlow Bonebed.	*	.	.	.	.	.	.	.	.	.	.
Sphagodus pristodontus.	Ag. Sil. Sys. 606.	Ludlow Bonebed.	*	.	.	.	.	.	.	.	.	.	.
Sclerodus pustuliferus.	Ag. Sil. Sys. 606.	Ludlow Bonebed.	*	.	.	.	.	.	.	.	.	.	.

In the foregoing list, the names at the bottom of each page are synonymes, to which reference is made by small letters from the more recent names in the list, as given higher up in the same page.

Name.	Authority.	Locality.	Mur. Upper.	Mur. Lower.	Phil. Upper.	Phil. Lower.	Sedg. Upper.	Sedg. Lower.	Irish, M'Coy. Tyrone.	Irish, M'Coy. Galway.	Irish, M'Coy. Kild. Dubl.	Irish, M'Coy. W. W. W.	Irish, M'Coy. Kerry.
CEPHALOPODA—*cont.*													
Orthoceras attenuatum.	Sow. Sil. Sys. 632.	Banks of Onny.	*	.	.	.	.	.	.	.	.	.	.
" Avelinii.	Salt. Sil. 50.	Stiper Stones W.	.	.	.	.	.	*	.	.	.	.	.
" baculiforme[a].	Salt. P. Fos. Ap. p. vi.	Brigsteer, Kildare.	.	.	.	.	*	.	.	.	*	.	.
" Barrandii.	Salt. G. Jour. vii. 177.	Mullock, Ayr, Tirnaskea.	.	.	.	.	.	*	*	.	.	.	.
" bilineatum[b].	M'C. Pal. Fos. 319.	Girvan, Ayr.	.	.	.	.	.	*	*	.	.	.	.
" breviconicum.	Port. G. Rep. 373.	Tirnaskea.	.	.	.	.	.	.	*	.	.	.	.
" Brongniartii.	Port. G. Rep. 368.	Desertcreat.	.	.	.	.	.	.	*	.	.	.	.
" bullatum[c].	Sow. Sil. Sys. 604.	Malverns, Llandilo.	*	.	5	3	*	*	.	*	.	.	*
" canaliculatum.	Sow. Sil. Sys. 632.	Ledbury.	*	.	.	1	.	.	.	.	.	.	.
" centrale.	M'C. Pal. Fos. 319.	Kendal, Llandilo.	.	.	.	.	*	*	.	.	.	.	.
" coralliforme.	M'C. Sil. Fos. 4.	Blackwater.	.	.	.	.	.	.	.	*	.	.	.
" dimidiatum.	Sow. Sil. Sys. 620.	Radnor Forest.	*	.	.	.	*	.	.	.	.	.	.
" distans.	Sow. Sil. Sys. 619.	Aymestry.	*	.	.	.	.	.	.	.	.	.	.
" encrinale.	Salt. Sil. 50.	Stiper Stones W.	.	.	.	.	.	*	.	.	.	.	.
" elongatocinctum.	Port. G. Rep. 372.	Tirnaskea.	.	.	.	.	.	.	*	.	.	.	.
" excentricum.	Sow. Sil. Sys. 631.	Old Radnor.	*	.	1	.	.	.	.	.	.	.	.
" filosum.	Sow. Sil. Sys. 620.	Ludlow, Tullyconnor.	*	.	.	.	*	*	.	*	.	.	.
" gregarium.	Sow. Sil. Sys. 619.	Ludlow, Tyrone.	*	.	.	.	.	.	*	*	*	.	.
" ibex[d].	Sow. Sil. Sys. 622.	Ludlow, Marwood.	*	.	5	2	*	*	.	*	.	.	*
" imbricatum.	Sow. Sil. Sys. 620.	Ludlow, Ferriter's.	*	.	3	1	*	.	.	.	.	.	*
" laqueatum.	M'C. Pal. Fos. 315.	Westmoreland.	.	.	.	.	*	*	.	.	.	.	.
" lineolatum.	Phil. Pal. Fos. 111.	Croyde Bay.	.	.	.	.	*	.	.	.	.	.	.
" Ludense[e].	Sow. Sil. Sys. 619.	Ludlow.	*	.	2	.	*	.	.	.	.	.	.
" Maclareni.	Salt. Sil. 176.	Pentland Hills.	.	.	.	.	*	.	.	.	.	.	.
" Marloense.	Phil. G. Sur. ii. 247.	Wooltack Bay.	.	.	.	1	.	.	.	.	.	.	.
" Mocktreense.	Sow. Sil. Sys. 616.	Mocktree, Abberley.	*	.	.	.	*	.	.	.	.	.	.
" nummularium.	Sow. Sil. Sys. 632.	Whitfield Quarry.	*	*	1	.	.	.	.	.	.	.	.
" perannulatum.	Port. G. Rep. 367.	Desertcreat.	.	.	.	.	.	.	*	.	.	.	.
" per-elegans[f].	Salt. Sow. S. Sys. 622.	Ludlow.	*	.	4	1	.	.	.	.	.	.	.
" politum.	M'C. Pal. Fos. 316.	Glenquapple, Ayr.	.	.	.	.	.	*	.	.	.	.	.
" Pomeroense.	Port. G. Rep. 370.	Desertcreat.	.	.	.	1	.	.	*	.	.	.	.
" primævum[g].	Forbes, G. Jour.	Radnorshire.	.	.	.	.	.	*	.	.	.	.	.
" striatum.	Sow. Sil. Sys. 604.	Horeb Chapel.	*	.	.	.	.	.	.	.	.	.	.
" subgregarium.	M'C. Sil. Fos. 9.	Ardaun, Boocaun.	.	.	.	.	.	.	.	*	.	.	.
" subundulatum[h].	Port. G. Rep. 378.	Tirnaskea, N. Wales.	.	.	.	.	.	*	*	.	.	.	*
" tentaculare.	Phil. Pal. Fos. 112.	Baggy Point, Brushford.	.	.	.	.	*	.	.	.	.	.	.
" tenuiannulatum.	M'C. Pal. Fos. 320.	Shropshire.	.	.	.	.	1	.	.	.	.	.	.
" tenuicinctum.	Port. G. Rep. 371.	Tirnaskea, Bala.	.	.	.	.	.	*	*	*	*	*	.
" tenuistriatum.	M'C. Pal. Fos. 405.	Mulock, Petherwin, Tirnaskea.	.	.	.	.	*	.	*	.	.	.	.
" textile.	Phil. G. Sur. ii. 249.	Freshwater, East.	.	.	.	1	.	.	.	.	.	.	.
" torquatum.	M'C. P. Fos. App. vii.	Kendal.	.	.	.	.	*	.	.	.	.	.	.
" tracheale[i].	Sow. Sil. Sys. 604.	Horeb Chapel.	*	.	1	1	*	.	.	.	.	.	.
" vagans.	M'C. Pal. Fos. 318.	Bala, Coniston.	.	.	.	.	.	*	.	.	.	.	.
" vaginatum.	Salt. G. Jour. vii. 377.	Ardwell.	.	.	.	.	*	.	.	.	.	.	.
" ventricosum[j].	Sharpe, G. J. ii. t. 13.	Saw Mill, Builth.	.	.	.	.	.	*	.	.	.	.	.
Phragmoceras arcuatum[k].	Sow. Sil. Sys. 621.	Leintwardine.	*	.	.	.	*	.	*	.	.	.	.
" compressum.	Sow. Sil. Sys. 621.	Aymestry, Tirnaskea.	*	.	.	1	.	.	*	.	.	.	.
" intermedium.	M'C. Pal Fos. 322.	Leintwardine.	.	.	.	.	*	.	.	.	.	.	.
" nautileum.	Sow. Sil. Sys. 622.	Middleton Hall.	*	.	.	3	.	.	.	.	.	.	.
" pyriforme[l].	Sow. Sil. Sys. 620.	Aymestry.	*	.	2	1	*	.	.	.	.	.	.
" ventricosum.	Sow. Sil. Sys. 621.	Aymestry.	*	.	.	.	*	.	.	.	.	.	.
Poterioceras approximatum[m].	M'C. Sil. Fos. 7.	Lettershanbally.	.	.	.	.	.	.	*	*	.	.	.
Tretoceras bisiphonatum.	Sow. Sil. Sys. 642.	Gorllwynfach.	.	*	.	1	.	.	.	.	.	.	.
" semipartitum.	Sow. Sil. Sys. 604.	Horeb Chapel.	*	.	.	2	.	.	.	*	.	.	.
PISCES.													
Cephalaspis Lyellii.	Ag. Sil. Sys. 589.	Herefordshire.	*	.	.	.	.	.	.	.	.	.	.
" rostratus.	Ag. Sil. Sys. 592.	Whithatch.	*	.	.	.	.	.	.	.	.	.	.
" Lewisii.	Ag. Sil. Sys. 593.	Whithatch, Shropshire.	*	.	.	.	.	.	.	.	.	.	.

[a] Ortho. linearis.
[b] O. calamiteum.
[c] Orth. striatum.
[d] O. articulatum.
[e] Orth. distans.
[f] Lituites articulata.
[g] Criseis primævum.
[h] Criseis Sedgwickii.
[i] O. per-elegans.
[j] Criseis ventricosum.
[k] Phrag. intermedium.
[l] Orthoceras pyriforme.
[m] Orth. subfusiforme.

Name.	Authority.	Locality.	Mur. Upper.	Mur. Lower.	Phil. Upper.	Phil. Lower.	Sedg. Upper.	Sedg. Lower.	Irish, M'Coy. Tyrone.	Irish, M'Coy. Galway.	Irish, M'Coy. Kild. Dubl.	Irish, M'Coy. W. W. W.	Irish, M'Coy. Kerry.
PISCES—*continued.*													
Cephalaspis Lloydii.	Ag. Sil. Sys. 594.	Hereford.	*	.	.	.	.	.	.	.	.	.	.
Cheiracanthus Murchisoni.	Ag. Sil. Sys. 601.	Gamrie.	*	.	.	.	.	.	.	.	.	.	.
„ minor.	Ag. Sil. Sys. 601.	Stromness, Moray.	*	.	.	.	.	.	.	.	.	.	.
Cheirolepis Traillii.	Ag. Sil. Sys. 601.	Pomona.	*	.	.	.	.	.	.	.	.	.	.
„ uragus.	Ag. Sil. Sys. 601.	Gamrie.	*	.	.	.	.	.	.	.	.	.	.
Ctenacanthus ornatus.	Ag. Sil. Sys. 597.	Abergavenny.	*	.	.	.	.	.	.	.	.	.	.
Dipterus macrolepidotus.	Ag. Sil. Sys. 599.	Downton Castle.	*	.	.	.	.	.	.	.	.	.	.
Holophtychyus Nobillissimus.	Ag. Sil. Sys. 599.	Crickhowell.	*	.	.	.	.	.	.	.	.	.	.
Onchus arcuatus.	Ag. Sil. Sys. 596.	Bromyard.	*	.	.	.	.	.	.	.	.	.	.
„ Murchisoni.	Ag. Sil. Sys. 596.	Southstone rock.	*	.	.	.	.	.	.	.	.	.	.
„ semistriatus.	Ag. Sil. Sys. 607.	Ludlow.		.	.	.	.	.	.	.	.	.	.
„ tenuistriatus.	Ag. Sil. Sys. 607.	Ludlow Bonebed.	*	.	.	.	.	.	.	.	.	.	.
Osteolepis macrolepidotus.	Val. and Pent. Sil. Sys. 601.	Cromarty.	*	.	.	.	.	.	.	.	.	.	.
„ microlepidotus.	Val. and Pent. Sil. Sys. 601.	Caithness.	*	.	.	.	.	.	.	.	.	.	.
Plectrodus mirabilis.	Ag. Sil. Sys. 606.	Ludlow Bonebed.	*	.	.	.	.	.	.	.	.	.	.
Thelodus parvidens.	Ag. Sil. Sys. 606.	Ludlow Bonebed.	*	.	.	.	.	.	.	.	.	.	.
Sphagodus pristodontus.	Ag. Sil. Sys. 606.	Ludlow Bonebed.	*	.	.	.	.	.	.	.	.	.	.
Sclerodus pustuliferus.	Ag. Sil. Sys. 606.	Ludlow Bonebed.	*	.	.	.	.	.	.	.	.	.	.

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